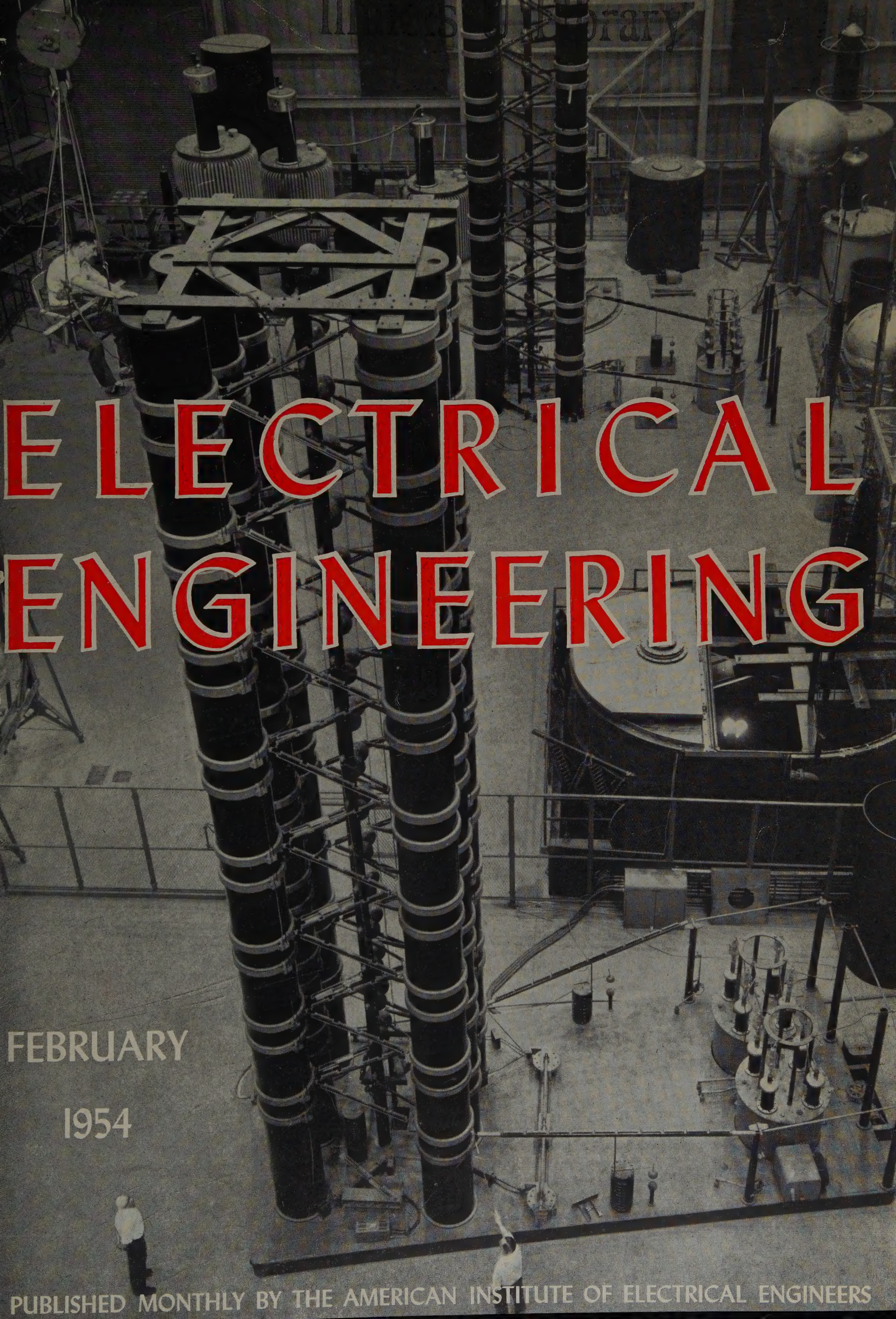
# ELECTRICAL ENGINEERING



FEBRUARY

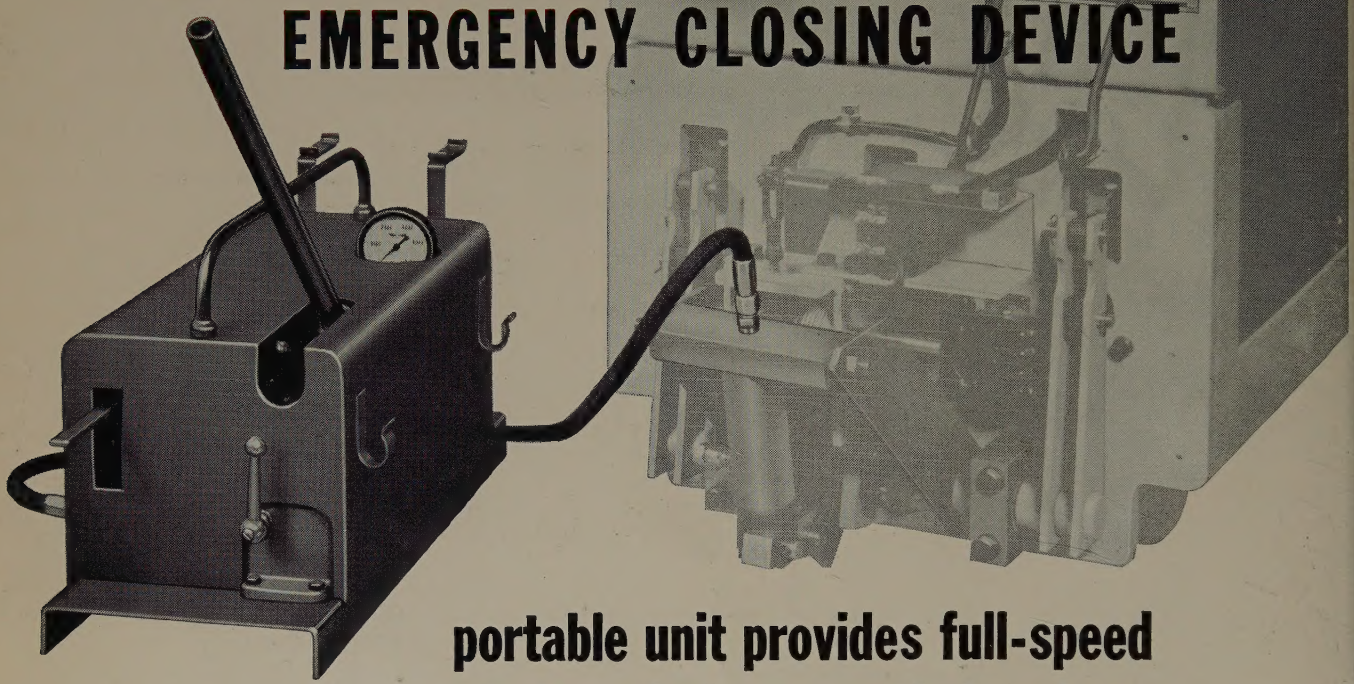
1954

PUBLISHED MONTHLY BY THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

# new

ALLIS-CHALMERS PROGRESS IN Switchgear

## EMERGENCY CLOSING DEVICE



## portable unit provides full-speed closing of air magnetic breakers

Here's a safe, reliable method of emergency closing an air magnetic breaker onto an energized line where no source of control power is available.

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**WHY USE THIS CLOSER?**

Because it is safe, reliable and fast. An air breaker closing on an energized line must be closed at normal speed. Using the usual manual emergency handle this cannot be done. This device affords the necessary speed.

**WHEN DO YOU NEED THIS CLOSER?**

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*Pneu-Draulic* is an Allis-Chalmers trademark.

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# ELECTRICAL ENGINEERING

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**The Cover:** A bosun chair equipped with a safety belt for use when working on the upper parts of impulse generators or on elevated testing circuits is one of the safety devices discussed on pages 115–19.

FEBRUARY
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***Another new development using***

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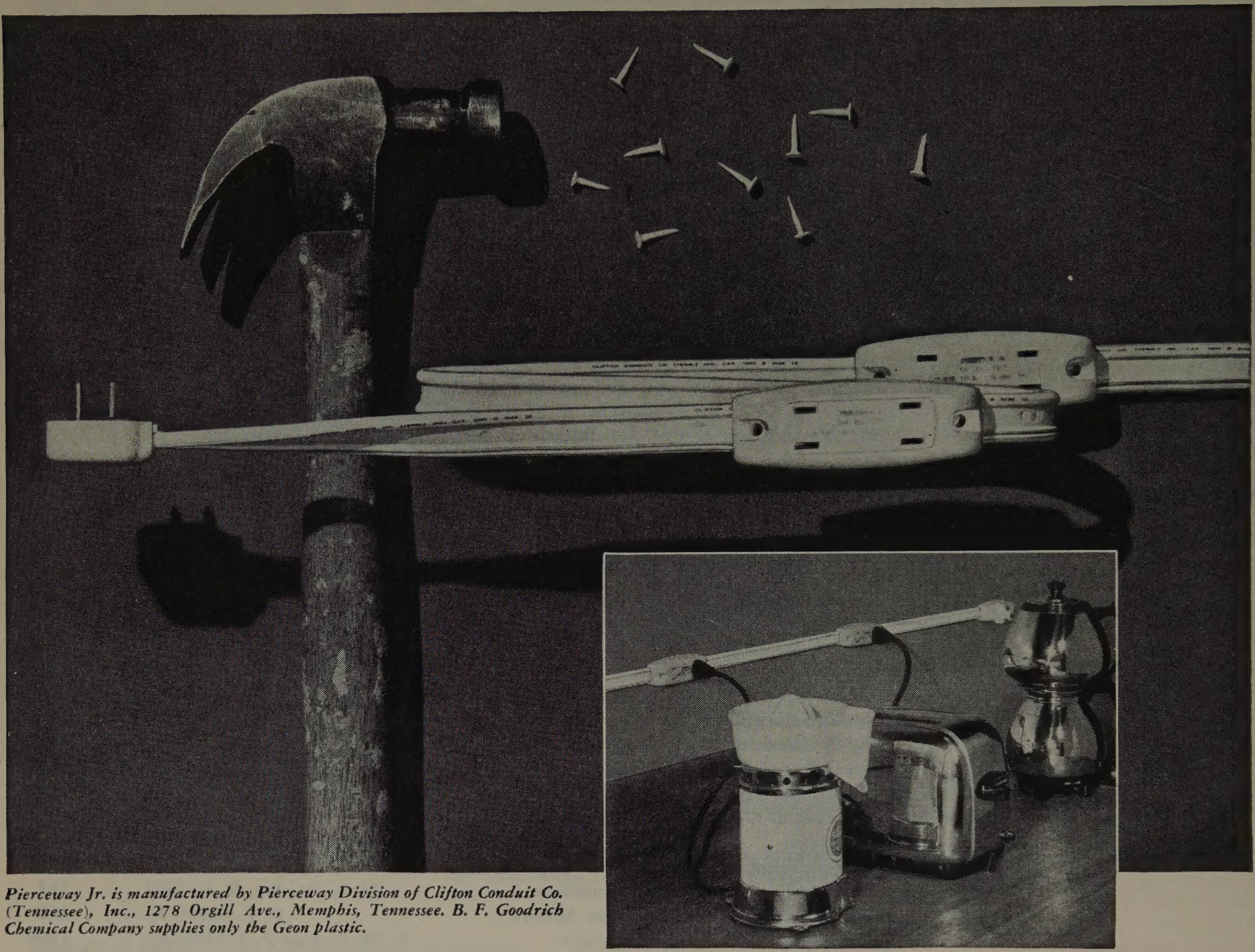

*Pierceway Jr. is manufactured by Pierceway Division of Clifton Conduit Co. (Tennessee), Inc., 1278 Orgill Ave., Memphis, Tennessee. B. F. Goodrich Chemical Company supplies only the Geon plastic.*

## More electrical outlets?... *All you need is a hammer!*

### *Handy String of 6 Duplex Outlets Made from Geon Materials*

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**GEON polyvinyl materials • HYCAR American rubber • GOOD-RITE chemicals and plasticizers • HARMON colors**

# HIGHLIGHTS........

**Winter General Meeting.** As this issue goes to press, electrical engineers from all parts of this country and abroad are attending the 1954 Winter General Meeting of the Institute at the Hotel Statler in New York, N. Y. The week's activities, including a record number of technical papers, will be reported in the March issue.

**Of Current Interest.** Among the items of current interest described in this issue are an automatic electronic system for bringing aircraft into a base at precise intervals of 30 seconds (*pages 183–4*), and a new electronic fish-finder that locates fish, spots underwater hazards to nets, aids navigation, and acts as an underwater depth indicator (*pages 186–7*).

**Evaluation of Engineering Education.** The great progress in the physical sciences during the past decade is now evident in the increased demands being placed upon the engineering profession. A committee formed in 1952 to determine the pattern that engineering education should take now makes its preliminary report (*pages 121–3*).

**Evolution of American Standards.** At its annual meeting in New York City on October 19, 1953, the American Standards Association (ASA) marked the 35th anniversary of its founding. Chairman at that first meeting in 1918 was Dr. Comfort A. Adams, then president of the Institute. In their addresses at the Founders Day ceremonies, Dr. Adams, as AIEE representative, presented some personal reminiscences of those early days of standardization (*pages 105–06*), and Roger E. Gay, current president of the ASA, pointed out that the Association, having passed four important milestones in its history, now is facing its fifth milestone as America enters the age of automation (*pages 106–09*).

**Pacific Northwest 1952 Power Shortage.** The causes and effects of power shortages are seldom published in any detail. Here a major shortage is discussed which should prove informative to the entire power industry (*pages 111–15*).

**Economic Aspects of Oil-Well Beam Pumping.** The factors which must be examined in detail in each specific oil-well beam pumping installation to determine which type of prime mover will prove the most economical and efficient are discussed under the categories of investment cost, operating cost, and cost of lost production due to down time (*pages 131–3*).

**Safety in High-Voltage Testing.** The electrical and mechanical safety measures employed in a high-voltage laboratory are described. Safe working methods are discussed and the importance of developing a group safety consciousness is emphasized (*pages 115–19*).

**Diesel-Electric Rail Cars.** Railroads are finding that rail cars offer a satisfactory solution to many of their passenger traffic problems. Their present application on domestic railroads is surveyed and a comparison is made between diesel-hydraulic and diesel-electric drives (*pages 125–7*).

**Pilot-Wire Relaying Utilizing the Product Differential Relay.** This scheme permits a wide latitude in the selection of current transformers and types of line terminations. It also provides protection of station equipment against high induced pilot wire to ground voltages (*pages 137–42*).

**Joint Use of Wood Pole Lines With Increasing Line Voltages.** The basis for engineering wood pole lines to carry jointly both power and communication facilities with safety to the public, utility workers, and property are discussed. The use of co-ordinated protection by the two utilities has made it practicable to continue joint use as the power companies have increased line voltages (*pages 142–5*).

**Automatic Tripping for Turbine-Generator and Boiler Protection.** The general protection setup adopted at the Astoria Generating Station in New York, N. Y., is described with its boiler, turbine, and electric protective devices co-ordinated for tripping completely or partially the generating unit from the coal pile to the high-voltage bus as required by the kind of failure which occurs. This type of protective arrangement is proposed for general consideration by the industry (*pages 149–54*).

**How Should a Manager Spend His Time?** In a long career as a management consultant, the author has observed both managers who knew how to spend their time and managers who wasted it. Those who get the most out of time invariably observe four basic rules which are described (*pages 166–8*).

**170-Megacycle Radiation Survey for Bonneville System Mobile Coverage.** The methods and procedures of very-high-frequency field radiation surveys conducted from approximately 50 radio stations are described. The project resulted in the efficient location of a minimum number of radio stations to provide complete mobile radio coverage of the Bonneville power transmission facilities (*pages 157–60*).

## News Index



### Bimonthly Publications

The bimonthly publications, *Communication and Electronics*, *Applications and Industry*, and *Power Apparatus and Systems*, contain the formally reviewed and approved numbered papers presented at General and District meetings and conferences. The publications are on an annual subscription basis. In consideration of payment of dues, members (exclusive of Student members) may receive one of the three publications; additional publications are offered to members at an annual subscription price of $2.50 each. The publications also are available to Student members at the annual subscription rate of $2.50 each. Nonmembers may subscribe on an advance annual subscription basis of $5.00 each (plus 50 cents for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.00 each. Discounts are allowed to libraries, publishers, and subscription agencies.

**Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grades, qualifications, and fees may be obtained from Mr. H. H. Henline, Secretary, 33 West 39th Street, New York 18, N. Y.**


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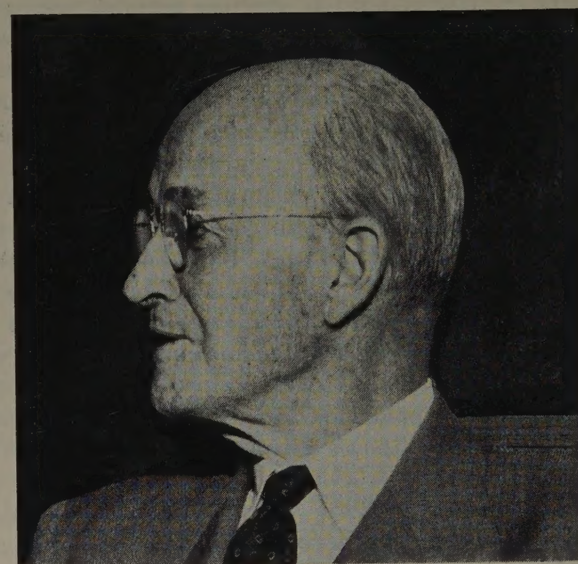
# AIEE's Role in the Creation of the American Standards Association

COMFORT A. ADAMS
FELLOW AIEE

**In this address commemorating the founding of the American Standards Association, Professor Adams, AIEE representative at the Founders' Day Ceremonies, presents some personal reminiscences of the preorganization days of the American Engineering Standards Committee, which was the forerunner of the ASA with its much broader scope.**



**Comfort A. Adams**

MY FIRST introduction to the field of standardization dates back to 1910 when my old friend D. C. Jackson, at that time president of the AIEE, appointed me chairman of its Standards Committee which was then in its early youth.

I found this work very congenial, stimulating, and worth while, and recall with real pleasure the intimate association with men like Steinmetz and Lamme. It constituted an important part of my education in the field of co-operation. One of my old friends once said that my first name should have been "Co-operation" rather than "Comfort" since I was involved in a number of important co-operative movements in the engineering field. My presidental address to the AIEE in 1919 was entitled "Co-operation" and my Steinmetz Memorial Lecture many years later was labeled "Co-operation Versus War." That was in the spring of 1942 when it was definitely appropriate.

## EARLY STANDARDIZATION ATTEMPTS

ONE OF THE first obstacles encountered by the AIEE Standards Committee was the overlapping of the fields of the several engineering societies and the messiness resulting from the attempt to draw definite lines between those fields. We first made the experiment of transmitting to our fellow societies copies of all of our documents which seemed to lie in the overlapping fields, with the suggestion that the other societies do likewise, so that we could get together or co-operate in that zone.

Unfortunately we did not meet with the generous response necessary for the purpose in hand. After further reflection we concluded that the desired co-operation could be obtained only through the organization of a Standards Committee covering the whole field of engineering. This in fact was the first stirring preceding the attempt to organize such a committee.

First there were many informal conferences with representatives of the other societies including some discussion in the engineering journals. The general attitude towards standardization has changed so much from that of those days that it probably would be difficult for most of our recent adherents to appreciate the number of obstacles to be overcome, and the educational effort involved.

However, after some months of this preliminary work, the AIEE Board of Directors at its meeting of June 28, 1916, acting on the recommendation of its Standards Committee, voted to invite each of the four other societies to appoint three members to an Organization Committee, to explore the whole problem and if possible to present a plan of organization.

It was thus about 28 months from the date of this vote to the final report of the Organization Committee, or more than 3 years from the first conviction as to the need.

A complete history of this period citing even the major obstacles and the struggles involved in dissolving them would be far outside the limits of my space as well as of my memory and of your patience.

However, I do wish to mention one major obstacle which is present in all efforts to establish co-operative organizations. This may be broadly referred to as "sovereignty" and becomes almost insurmountable in the case of international co-operation such as the United Nations.

The fact is that no real co-operation is possible without the sacrifice of some degree of sovereignty, not only of the organizations involved but sometimes of individuals. In all cases it is the fear of losing something which at the

Essentially full text of an address presented at the Founders' Day Ceremonies at the 35th annual meeting of the American Standards Association, New York, N. Y., October 19, 1953.

Comfort A. Adams, Philadelphia, Pa., is a past president of the Institute (1918–19).

moment seems more important to some of those concerned, than the ultimate objective. Often this fear is coupled with distrust of the other co-operating agencies or of individuals connected therewith. As one innocent instance of this type, initially one of our most hesitant conservatives was our dear old friend Edgar Marburg who was the founder of the American Society for Testing Materials and later contributed so much to the success of our committee. At the beginning he was distrustful of my personal objectives. This was before we had had any personal contacts. However, he changed completely after one personal conference. I shall never forget the last meeting of the Organization Committee which he attended. He was ill at the time, under his doctor's orders, and took no part in the discussion. Noting this fact, one of the other members of the committee asked for his opinion on a controversial question. His answer was that he was following the doctor's orders religiously since he was apt to get overexcited when participating in such a discussion. "But," he said, "anything that is acceptable to the chairman is acceptable to me."

This was keenly remembered, since it was one of the most highly appreciated compliments that I had ever received, particularly in view of his initial distrust.

Mr. Marburg passed on shortly after this event, and before he could see the successful result.

### CONTRIBUTIONS OF OTHERS

Although thus far I have referred primarily to the part played by the AIEE, I would be the last one to fail to appreciate the part played by the other Founder Societies and their delegates on the Organization Committee.

It was an honor to be associated with that group of eminent men, several of whom were past presidents of their sponsor societies. It is a pleasure to recall the friendships made during that period, and to remember so little evidence of either personal or organizational bias.

On the personal side I disclaim any credit except that of an enthusiast riding his major hobby, with a deep conviction as to its practical value. The results in this case seem to support that conviction. But even in this realm I had invaluable support from my old friend and colleague, Henry Hobart of the General Electric Company. He could not receive too much credit for more than 3 years of enthusiastic, faithful, efficient, and unselfish service in a worthy cause.

I also received much help in the early days from Charles LeMaistre, C.B.E., who had recently organized the British Standards Association, of which he was secretary for many years. Owing to his experience in this particular field, his help was specific, useful, and comforting to us as beginners.

Both of these men have passed on, the latter only a few months ago.

One of the penalties of growing old in the harness seems to be this passing of so many old friends. However they really live not only in our memories, but also in the structures which they have helped to build.

In this case the structure is the American Standards Association and this Commemorative Message is addressed to the memory of the 15 men who served faithfully and well in laying its foundation. I am glad to be counted as one of that group, but as only *one*.

# The Fifth Milestone in Standardization

ROGER E. GAY

Thirty-five years ago—on Saturday, October 19, 1918, to be exact—a group of 15 farsighted business executives held a meeting in the Engineering Societies Building in New York City. They were representatives of the country's five leading engineering societies, and they had called the meeting to organize the American Engineering Standards Committee (AESC).

As its first act at that first meeting, the committee elected a very distinguished gentleman as its chairman: Dr. Comfort A. Adams of the Harvard Engineering School, president of the AIEE and a member of The American Society of Mechanical Engineers. The standards movement of the United States owes an infinite and unrepayable debt of gratitude to Professor Adams for his wise and patient leadership during the founding years of the national movement.

At that first meeting, the committee approved rules of procedure and a tentative constitution setting forth its scope of work and its aims. It considered correspondence from the American Gear Manufacturers Association asking assistance in preparation of a national standard for gears. It invited the United States Departments of

Essentially full text of an address presented at the 35th annual meeting of the American Standards Association held in conjunction with the Fourth National Standardization Conference of the ASA, New York, N. Y., October 19, 1953.

Roger E. Gay, president, The Bristol Brass Corporation, Bristol, Conn., is president of the American Standards Association.

War, Navy, and Commerce to join the committee with the standing of founders. (All three accepted.) It established a budget for the year 1919, a total of $6,000. And it moved to promote relations with the standards bodies of Britain, France, Italy, and Switzerland.

Here is a formal statement the committee issued at that time, taken from the *Scientific American* for July 1919:

"It is the unanimous conclusion of the committee and of all of those who have been consulted who have been active in standardization work, that such an organization is urgently needed. In the past there have been many occasions when two or more organizations have formulated standards for substantially the same thing. The committee will furnish a means by which any organization intending to define a standard can readily ascertain what others are interested and should be consulted about it. It provides definite machinery for securing co-operation and preventing duplication of work. *At present there is no such means.*"

**Having passed four important milestones during the 35 years of its history, in this anniversary address the president of the American Standards Association points out that the ASA is now faced by its fifth great milestone—the result of the transition from mechanization to automation.**

From what I hear and read of that first meeting, I am impressed by the fact that the hopes, fears, and problems of those men were strikingly similar to our own today. They had seen in a World War that the American system was capable of tremendous production and tremendous waste. They had seen the confusion and dissipation of resources that result when men and nations speak different industrial languages. They were faced with the unknown consequences of an enormously expanded productive capacity. Technology operating under the forced draft of war had brought forth new products and whole new industries that already were displacing other products and other industries.

These 15 men, in the closing weeks of the war, came together to lay the foundations for sound engineering standardization. I have called them farsighted, and I think with good cause. The constitution they drew up has served as a guide throughout the 35 years of their organization. It has been amended, its scope has been broadened, but its basic objectives and basic principles never have changed.

## FOUR GREAT MILESTONES

Two years after it was founded, this association came to the first of four great milestones it has passed in its 35-year history. Each milestone came at a moment of crisis in the standards movement. Each now marks a spot where important basic decisions were made and a new course was laid down.

In that year, 1920, the founders reorganized the AESC in an effort to broaden the standards movement. They invited all the technical societies, trade associations, professional groups, private companies, and governmental bodies that were interested in national standards to join them. The AESC mission was now to act as the national clearinghouse for standards. Its function was to simplify the development of standards; to eliminate duplication and variation of standards; and to weld conflicting standards into a single, generally accepted standard designated "American Standard."

The second milestone came in 1928 when the structure of the organization was changed from a committee to a full-fledged association. A Board of Directors was created to handle administration policy and finance. A standards council representing all member organizations was established to supervise the technical activities. The name was changed to the American Standards Association (ASA).

The third milestone came in 1945. The ASA had survived the depression and had lent its energies to developing American War Standards during the second World War. At the end of that war, the questions arose: What is to happen to the ASA and to the voluntary standards movement in America?

The answers were given in 1946 when a group of top businessmen, headed by Charles E. Wilson, then president of General Electric Company, reached an historic agreement with the Secretary of Commerce of the United States.

Under this agreement, the Federal Government endorsed ASA as the national clearinghouse for standards and encouraged industry to implement the association for its postwar role. ASA removed all restrictions from its scope enabling it "to handle any standards or standardization project which deserves national recognition, whether for raw materials, intermediate goods, production goods, consumer goods, for safety, for engineering, or for commercial transactions."

The voluntary standards movement of this nation passed its fourth great milestone in 1951. This was the historic reversal of Federal Government policy towards industry standards and the people who make them.

You are all familiar with what Federal policy had been in the past, with the disinclination of government agencies to accept tested industry standards on the hundreds of thousands of articles of common use that it bought each year. You doubtless know, too, the bad effects that arose from that policy, effects that are inevitable when standards and specifications are changed arbitrarily in a mass-production economy.

Just 2 years ago, the key procurement agencies agreed henceforth to base Federal and military standards, whereever possible, on recognized industry and technical society standards. They declared further that they would cooperate more closely with industry in standards work.

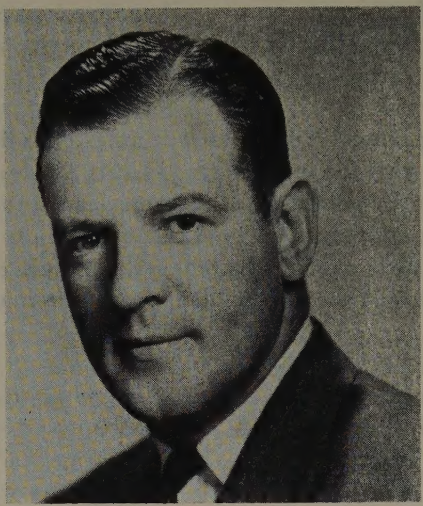
The Federal Government already has adopted a number of American Standards, in whole or in part, by reference or by transcription. It can do this readily because all the interested parties participated in the making of these standards—including the Federal Government itself.

Today, as it closes its 35th year, ASA has a record of

solid growth and accomplishment behind it. Its membership totals 114 societies and associations, and 2,337 companies. It has approved 1,350 American Standards, including 160 American Safety Standards, which cut across virtually every industry in the land.

Committees now are engaged on about 300 standardization projects under ASA procedures. About 4,000 individual technicians, engineers, executives, and other experts are working on such committees.

It is in the good will and support of these men, and the organizations they represent, that the true measure of growth and accomplishment of ASA is to be found. Without them, there simply would be no ASA. These men, these organizations, created the 1,350 American Standards now in existence. ASA did not make them; ASA simply provided the machinery under which many of them were made, and the judicial procedures under which they were certified as true national standards meeting ASA requirements.



**Roger E. Gay**

In the creation of these 1,350 Standards, there were difficulties to be ironed out as to the amount and direction of effort to be contributed by each party. There were misunderstandings to be cleared up, particularly in order that all concerned might understand that ASA is not trying to usurp the prerogatives of any other body. The services of their efforts speak well for the statesmanship of American business, the vision of American business, and the faith of both in a great cause.

We at ASA are acutely conscious of this last point. Our constitutional directive calls upon us to promote knowledge of standards and the use of standards. In so doing, we are aware always that we are promoting the work of others, work with which in some cases we had no connection until it was completed. We never have claimed credit for that work, and we try hard to avoid the appearance of claiming credit for it.

Now the voluntary standards movement in this country is approaching a fifth great milestone, a fifth point where important basic decisions must be made and a new course laid down.

Americans are obviously on the threshold of a new phase of the national economy. Perhaps we even are headed into a new chapter of the Industrial Revolution itself. In either case, the leaders of American business and industry soon must decide just what they want of the standards movement and of the ASA in the new and strange economy we are about to enter.

For 35 years we have been using only two cylinders of an 8-cylinder standards engine. We have been using standards chiefly to solve problems, to reduce confusion, and to meet existing emergencies. That, of course, is not the proper function of standards. It is not the kind of standards activity that will serve us as we need to be served in standards in the critical years ahead.

Consider for just a moment what has happened to the American economy in the past 12 years, and then consider the short-range effects of those developments. We have had three great waves of industrial expansion in that time. First, in the space of the 4 war years we built a new economy for the nation. Then, in 4 postwar years, American industry converted that economy to peacetime uses, and poured some 115 billion dollars in new and improved plants, to create a second enormous spurt in our productive capacity. And then, after the invasion of South Korea, we virtually laid down a new industrial base for the nation. Our productive capacity now is nearly double what it was in 1940, and considerably more than half of that increase has come in the past 3 years.

Today we have overcapacity in everything except aluminum, some types of steel, and nickel. Federal expenditures are declining at the same time that private industry is ending much of its own capital expenditures. The steel industry, for instance, plans no new ingot capacity for some years. The Federal Government, which has issued about 27 billion dollars in certificates of necessity to 233 industries, now is beginning to close out that program.

In addition, industry is operating at an abnormally high break-even point. Fixed or semifixed costs are so high that a company must turn over about twice as many dollar sales per employee to pay his wage and maintain the same profit as before 1940. At the same time, economists frighten us with the information that the American standard of living is so high that our people could postpone 40 per cent of their buying for 4 years and still maintain a decent standard of living.

There are many favorable factors here, of course, ranging from the stimulus of possible tax cuts next year to the great increase in the number of new families coming along. It is entirely probable, as the Standard Factors Corporation states, that the peace in Korea will bring "the finest surge of competitive effort and the most amazing output of new products we ever have seen." The point is simply this. Virtually every expert writing on this subject today, regardless of his point of view, agrees on one point: Our hope for meeting the grave economic problems of overcapacity and high break-even point lies in cutting costs through better equipment, new products, new processes, and all-around added efficiency. The experts, in their textbook language, call it raising the nation's productivity, "improving the combination of elements that determine the effectiveness of effort in production."

That is what we have been doing in this country for almost a century, at the rate of about 3 per cent per year.

It is an American formula that has made us economically great and that no other nation seems able to copy or even to comprehend.

Now the experts tell us that we must continue to do more of the same thing, but do it a great deal better. I think they are right. It seems apparent that the marginal producer who does not modernize, the company that cannot carry some of its capacity idle in slow times and make it pay with added efficiency, is going to get hurt in this coming surge of competitive effort. The nation that does not cut the price of its commodities through added efficiency is going to get hurt in the markets of the world. The magazine *Factory* recently estimated that our output per worker must climb 43 per cent by 1960, twice as fast as between 1940–50, in order to maintain our present standard of living.

There are many ways and many areas in which a company and an industry can cut its costs. Better, more intense application of the principles of standardization is one of those ways. I do not think I need relate the part that standards have played in building the American economy in this century. I would like to stress, however, that of all the elements that combine to determine the effectiveness of effort in production, standardization is still one of the most promising.

I do not want to claim too much for standardization. It is a critically important factor, but it is not the only answer, and it is not a cure-all. On this point, I am sometimes reminded of the story of the three tailors who operated side by side on a New York street. One tailor put up a large sign: "Best Tailor in New York." The second tailor put up a larger sign: "Best Tailor in the United States." The third tailor then put up a modest little sign reading: "Best Tailor in this Block." We in the standards movement are like the third tailor. We like to keep our claims on a modest level. We simply believe that standardization is the last great frontier of the American economy where major increases in efficiency and substantial cuts in costs can be made.

I have discussed some short-range changes in our economy. There are long-range changes in sight which I am scarcely able to understand, let alone try to explain. They lie in new products and new processes that push back our horizons into a new world in a new century.

Atomic energy is one of these. How can we assess the effects on our economy of a fuel, 1 pound of which holds the energy of about 3,000,000 tons of coal?

Electronics is another. Two hundred years ago we began to attach machinery to our tools, with a man at the handle for control. A few years ago we began to replace the man with routine automatic controls. Now we are teaching our machines to think. Their brains already can store information, profit by experience, and beat their inventors at a game of chess. And we are only in the first stages of this new science.

These machines open up entire new vistas of mechanical production. The magazine *Business Week* claims that this kind of production, called "automation," can give us strides in productivity that will make the advances of the past 50 years look small. It predicts bigger factories producing more goods with fewer people and believes that automation will spread to almost every industry. It adds that management then will be faced with problems of inconceivable complexity and magnitude.

## THE FIFTH MILESTONE

This is the fifth great milestone to which I referred earlier. This is the question that American businessmen soon must ask themselves. In such a strange economy of automation, is American industry going to try to continue using standards as it has used them in the past; improperly, inadequately, inefficiently? Is it going to keep on using standards to solve old problems, to meet recurring emergencies, to reduce the general confusion? Or are we going to use standards as they are meant to be used: to keep problems from arising; to stop emergencies from happening; to eliminate the confusion; to serve as the key elements in management control, co-ordination, integration, and planning?

As we enter the age of the electron and the atom, the standards' record in these new industries is spotty. A good start has been made in standards in certain areas of the electronics industry. A new committee within the framework of ASA has been created to handle future standardization on the national level. But other areas are untouched. We are now in a situation where private industry is about to be asked into a strange new field, that of atomic power; and that industry has virtually no American Standards of health, safety, manufacture, or operation in this field. Is that good?

We hold that predetermined standards are one of basic requirements of an orderly transition from today's mechanization to tomorrow's automation. Our plea to American industry is to build a comprehensive, integrated set of true national standards now, in advance of need. The alternative is to build them later in order to unscramble a mess that never should have happened.

In one of the first meetings of the American Engineering Standards Association, Professor Adams, the chairman, made this statement: "I think you cannot fail to see the tremendous possibilities and value to all industries, and to the nation as a whole, of this work of standardization..... If we can inject into other organizations the idea which we have evolved here—the idea of thorough, broad, and comprehensive co-operation in the making of standards, then I think we will have accomplished one of the biggest jobs that has ever been undertaken in this country. It would do more to solve some of the present economic problems of the United States than anything else we could do."

These are the words of a prophet. They are as true today as when they were spoken 35 years ago. The whole problem and promise of the standards movement is contained in that statement.

The founders of the ASA conceived a great basic principle. They converted it into a national cause. They created a sound organization to produce action. We are the inheritors of their principle, their cause, and their organization. As such, we are under deep obligation to live up to their record and to fulfill their expectations.

# Nondestructive Sensing of Magnetic Cores

D. A. BUCK W. I. FRANK

MAGNETIC CORES with rectangular hysteresis loops are of interest to the field of digital computers because of their ability to hold, or "remember," the direction in which they are magnetized. In digital computer terminology, a magnetic core may be said to contain a binary 0 if its remanent flux is positive or a binary 1 if its remanent flux is negative. A group of magnetic cores therefore can hold a pattern of 0's and 1's which make up a binary number.

The most common method for sensing the sign of the remanent flux of a core (reading the core) involves switching the flux to a reference direction, say the positive direction. In a winding on the core, a large pulse of voltage is generated if the flux changes from negative to positive. No pulse, or at most a small pulse, is generated if the flux is already positive. A binary 1 is indicated therefore by a large voltage pulse and a binary 0 by a small voltage pulse. Sensing the core in this manner destroys the information it contains since the core is left holding a 0 regardless of what it held just prior to sensing. To retain the information in the core, additional time must be allowed for the rewriting of a 1.

A method of sensing the sign of the remanent flux has been developed which does not destroy the information contained by the core. This method of nondestructive sensing involves the use of a quadrature field (Figure 1) set up at right angles to the direction of the remanent flux. The quadrature field, when pulsed, rotates the remanent flux vector momentarily away from its rest position. The amount of rotation is small, and because of the nature of the rectangular-loop magnetic material, the remanent flux vector falls back to its rest position when the quadrature field is removed. The momentary rotation of the remanent flux vector produces a voltage in the sensing winding because the flux component normal to the plane of this winding momentarily decreases. If the remanent flux is negative (core contains 1) the momentary reduction produces a positive pulse (Figure 2); whereas if it is positive (core contains 0) a negative pulse is produced. The polarity of the output pulse therefore indicates the information state of the magnetic core.

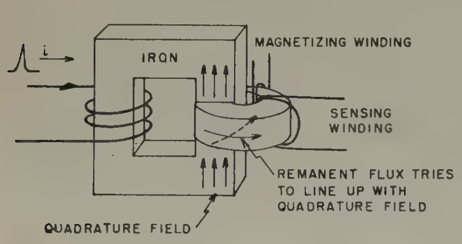
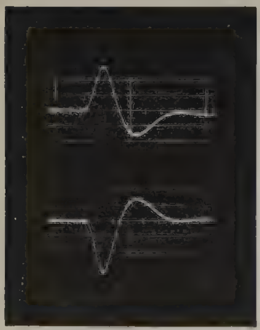



**Figure 1. Externally generated beta field**



"ONE"

"ZERO"

**Figure 2. Typical waveforms in an unterminated output winding**

Many methods can be used to set up the quadrature field. One of the most successful with ribbon-wound magnetic cores involves sending a pulse of current directly through the ribbon. The ribbon ends are brought out to terminals. Since the wraps are insulated from one another, a pulse of current can be made to flow through the magnetic ribbon. This current sets up a quadrature field within the ribbon itself and therefore involves no external flux path. With ferrite cores an external flux path for the quadrature field (Figure 1) gives the desired result. Another possibility is the "hollow doughnut" configuration wherein the quadrature-field winding is threaded through a circumferential hollow inside the memory core. Still another type of memory is under investigation in which tiny holes in a ferrite sheet operate as memory cells. The quardature winding is then threaded through a long nonintersecting hole which is at right angles to the memory holes.

If the quadrature field is made very strong, it can overwhelm the remanent flux and loss of information will then occur. Below this destructive limit the method is truly nondestructive; tests have been extended to over $10^9$ successive sensings without any loss of information. When one operates close to the destructive limit, however, partial loss of information can occur as indicated by the first sensing pulse being larger than the rest.

Sensing by this method is fast. Because only part of the remanent flux changes, sensing can be accomplished in a fraction of the usual switching time of the core; the pulses shown in Figure 2 are 0.2 microsecond in length. Because the flux changes rapidly, the output voltage pulses can be as high as 1 volt per turn. Another advantage of this scheme is that it represents the two information states of a core by pulses of opposite polarity rather than by the presence or absence of a pulse as in the older scheme. This method of sensing is adaptable to magnetic information-handling devices of many kinds.

Digest of paper 53-409, "Nondestructive Sensing of Magnetic Cores," recommended by the AIEE Committee on Computing Devices and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Kansas City, Mo., November 2–6, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

D. A. Buck and W. I. Frank are with Massachusetts Institute of Technology, Cambridge, Mass.

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# Pacific Northwest 1952 Power Shortage

J. P. JOLLIFFE
FELLOW AIEE

**One of the longest and most widespread power shortages ever experienced in the United States occurred in the Pacific Northwest in 1952 due to the extended drought. The way this shortage was handled both by advance planning and later revisions as conditions changed are presented.**

THE POWER shortage in the Pacific Northwest in 1952–53 was one of the most widespread and longest shortages that has occurred in the United States. There have been several power shortage conditions in the country during the past decade. For example, the shortage in the Southeast in 1941, Niagara Falls area in 1942, Maine in 1947, northern California in 1948, and the Pacific Northwest in 1949. These shortages were caused mainly by lack of generating capacity when very rapid growth of load resulted in a shortage of peaking capacity. The power shortage in the Northwest in 1952–53 was not one of lack of peaking capacity but a lack of sufficient water to meet the energy requirements of the area.

The Northwest Power Pool consists of 11 of the largest public utilities in the Northwest and includes all major utilities in Utah, Montana, Idaho, Washington, northern Oregon, and British Columbia. These utilities are all interconnected by a high-voltage transmission grid. There are 100 generating plants with over 6,600 megawatts of capacity connected to this grid (1952). The Power Pool is divided into two groups. The Montana Power Company, Utah Power and Light Company, and the Idaho Power Company comprise the Eastern Group. This grouping has been considered as a unit because it has been interconnected with the Western Group by a single interconnection which many times limits the amount of interchange available between the two areas. During this past year the practical limits of flow in an eastward direction were 40 megawatts on peak and 60 megawatts during light load hours. Westward flows were limited to 100 megawatts at peak periods. The Washington Water Power Company, Portland General Electric Company, Pacific Power and Light Company, City of Tacoma, City of Seattle, British Columbia Electric Company, and the Bonneville Power Administration comprise the Western Group. The resources available to the Pool are shown in Table I.

The Northwest Power Pool is a voluntary organization of the afore-named companies and has no legal entity. The objectives are: 1. Maximum load-carrying ability. 2. Better and more reliable service. 3. Conservation of fuel. 4. Increased economy of operation. The organization consists of an Operating Committee and a Co-ordinating Group. The Operating Committee consists of one representative from each member utility, this representative being thoroughly familiar with system operations and with sufficient authority to make operating decisions. All decisions of the Operating Committee are unanimous and no formal vote is taken. The Co-ordinating Group is a small staff of engineers who collect information, prepare reports, make studies, and act as a general clearing house for the Pool.

One of the important activities is the preparation, each year, of an operating program for the ensuing year. Each utility supplies the Co-ordinating Group with load estimates and data concerning plant facilities and capabilities. The aggregate of all these data is then considered as one integrated system and all the component parts are fitted together to provide the required or maximum load-carrying capacity under the most economical and practical operating program. In the Northwest, where hydroelectric plants provide the predominant electric resource, the matter of dependable stream flow each part of the year is of extreme importance. Therefore, the operating program considers as a prime factor for determination the ability to carry the area load if stream flows are as low as the worst year on record. The "critical" water year is the year in which the historic stream flow produces the minimum amount of power for the Pool as a whole. It does not represent the historical minimum flow for each river in the area, but does coincide with the historic minimum for the Columbia River in 1936–37. The "critical" year has the same aggregate flow as the historic minimum. Due to wide fluctuations in different years, the shape of the critical period in any particular watershed corresponds with the average of the 5 lowest water years in that watershed up to January 1, and the historical minimum flows for 1937 thereafter. This procedure does produce a seeming inconsistency as in July the resource in a critical year is higher than for the median year. This is because historically the early flows have been high in years when low natural flows occurred during the fall and winter. It is of small consequence as the total resource is considerably larger than load requirements.

A complete plan for each plant's operation is set up in advance, showing just what that plant is expected to do in carrying the load if a critical water year should occur. The critical year operating program shows in chart form the peak and energy each plant is to produce each month, it shows how much fuel will be burned by each steam plant and rule curves are drawn for each storage reservoir show-

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**J. P. Jolliffe** is with the Bonneville Power Administration, Portland, Oreg.

**Table I. Total Generating Capacity in Megawatts (December 1952)**

| | East Group | West Group | Total |
|---|---|---|---|
| Federal hydroelectric | 118 | 2,840 | 2,958 |
| Public agency hydroelectric | | 642 | 642 |
| Private utility hydroelectric | 898 | 851 | 1,749 |
| British Columbia Electric Company (Canada) | | 453 | 453 |
| Hydroelectric total | 1,016 | 4,786 | 5,802 |
| Public agency steam | | 98 | 98 |
| Private utility steam | 306 | 231 | 537 |
| Steam total | 306 | 329 | 635 |
| Generation total | 1,322 | 5,115 | 6,437 |
| Miscellaneous resources available | 54 | 136 | 190 |
| Total | 1,376 | 5,251 | 6,627 |

ing the elevation of the water in storage at each part of the year. These rule curves are a most important part of the program and indicate to the plant operator that if storage is maintained at the elevations shown and if the succeeding stream flow is no worse than the worst of previous record, the plant can produce for the remainder of the year the planned peaks and energy. In arriving at these rule curves, the seasonal stream flow diversities are utilized so that each plant is operated to make its maximum over-all contribution. A similar program also is set up each year based upon plant operation if average water conditions occur.

A very careful planning and use of stored water is essential in a year of low natural flow. There was considerable question raised by the general public at the beginning as to why there should be curtailment and yet the reservoirs were full. The reservoirs were still only slightly below rule curves at the time curtailment ceased. There is an infinite number of ways plans can be made to use the stored water. One obvious method would be to continue to serve all loads until the storage was used up. If this method were followed and critical hydro conditions continued, all storage would be evacuated early in January. The deficiency then would be over 50 per cent of the normal load level. There have been two methods commonly considered. In one, the deficiency is shaped in a trapezoidal pattern, the initial deficiency being about 50 per cent of the average and the final about 150 per cent of the average. While this use does not make the maximum use of the potential energy, it does provide an easy method of application. At the time curtailment must commence, there is still lots of water in storage and the probabilities are that water conditions will improve. If conditions do not improve, other factors that affect the public, such as domestic water supply, get considerable publicity. This all tends to make public acceptance of additional curtailment easier as the season progresses. In the other, the deficiency is spread uniformly over the storage control period. This has an advantage of protecting the maximum level of energy that can be carried through the season. It has a disadvantage in application if the average deficiency is large enough to have impact on the general economy of the area. The uniform deficiency plan has the advantage in that more energy is available during the storage control period. This is caused by maintaining higher reservoir elevations during the early part of the season and the natural flow of the river is utilized at a higher head. This gain is about 5 per cent under the system conditions of 1952.

The 1952–53 operating program indicated that if critical water occurred at all power plants, the area resources would be nearly 4 billion kilowatt-hours less than the estimated loads. Nonservice to interruptible consumers would reduce this deficiency to slightly over 1 billion kilowatt-hours. Reduction of interruptible loads presented no problem as contracts for this class of power recognize that under low water conditions no energy will be available. The major portion of the interruptible load was used in the reduction of aluminum which was in heavy demand for defense production. The Defense Production Administration, after full consideration, decided not to establish any priorities requiring delivery of energy to any customers using interruptible power. Figure 1 shows the effective ability of the Pool to meet the estimated loads if stream flows are equal to those of the critical year during the entire period of the 1952–53 operating year.

The summer of 1952 was the driest on record and stream flows were reduced seriously in the Western Group area. Actual water conditions in July and August were slightly below critical year flows. Loads were running below estimates, however, and no difficulties were encountered in carrying the loads. It was evident that should prevailing conditions continue, firm loads would have to be curtailed. The utilities in the Northwest recognized that responsibility for a curtailment program would require the Defense Electric Power Administration (DEPA) to take action in the pending situation. The responsibility for a curtailment program devolved on DEPA for a number of reasons. First, DEPA had the responsibility and authority to allocate electric energy to promote the national defense. Second, DEPA had the authority to require that certain contracts for the supply of electric energy should take priority over performance under any other contract. Third, no utility would be held liable in damages for any refusal to supply electric energy to any of its customers when such refusal resulted from compliance with a DEPA order. Fourth, no state in the area had legislation authorizing its officials to take the actions needed in support of a vigorous conservation program.

A proposed order to ration electric energy in the Northwest was prepared by DEPA in collaboration with the utilities in the affected area. The principles of DEPA's power conservation program embodied in the order were: 1. All possible measures should be taken to increase the electric power resources of the area. 2. The Defense Production Administration would determine which defense production loads required protection of their electric power supply, and any mandatory limitations would afford protection to such loads. 3. Mandatory curtailment of load would be confined to limitations on large electric power users because, as a practical matter, substantial savings of electric energy could not be accomplished by imposing limitations on smaller users nor could such limitations be effectively enforced. 4. Limitations on

less essential uses would be on a voluntary rather than on a mandatory basis, encouraging maximum local responsibility for this part of the program. 5. The curtailment of firm loads of large electric power users would be accomplished on a quota basis—by limiting each large user's consumption to a percentage of his consumption during a corresponding period of the previous year. The percentage would be calculated so that the combined effect of such firm power cuts and the savings of the voluntary program would reduce the load to the power resources available. 6. In determining the utilities to be covered by the order, the rule would be that any system that could not at all times keep its tie lines loaded into the systems which were short of power should be within the shortage area and subject to the limitation order. On the other hand, any system able to keep loaded at all times its tie lines into the systems which were short of power would be outside the shortage area and its consumers not subject to the conservation program. This rule for delimiting the shortage area is based upon the sound principle of expecting complete co-operation among adjoining electrical utility systems whenever any one is in unexpected or unavoidable trouble.

The order provided for a field representative and established an Advisory Committee consisting of two representatives from private utilities, two from nonfederal public utilities, and one from federally owned public utilities. It established the amount of 8,000 kilowatt-hours per week as the amount below which compulsory curtailment provisions would not apply. Atomic energy plants, military installations, and essential civilian services were exempted from the provisions of the mandatory curtailment provision.

As a base from which to measure the amount of reduction, a "weekly energy base" was established. The order described this as the normal base amount consumed by the customer in the like period in the previous year, as adjusted by the electrical utility serving the consumer on the basis of changes in the consumer's method of operating during or since the base period which result in changes in consumption. The adoption of the amount of 8,000 kilowatt-hours per week as the mandatory level resulted in slightly over 1,100 consumers being subject to mandatory curtailment. Considerable use made of the provision for adjusting the base consumption is indicated by the fact that over 480 consumers were granted adjustments to their base figure. This experience also indicates that in any future need a new method of determining such quota should be adopted.

The drought continued and on August 20 it became necessary to start reducing the amount of hydro-generated energy available for interruptible loads as continuation of such deliveries would jeopardize future service to firm loads. Steam-generated energy was still available and most interruptible customers chose to continue operation with the higher cost power. Stream flows continued to remain below the critical year level and by September 16 all available steam was required to carry firm loads. At this time the energy available from natural stream flow had dropped 1,300,000 average kilowatts from the capabilities on July 1.

Loads continued to underrun the estimates by 125,000 to 150,000 kilowatts. Part of this was caused by abnormally high temperatures that continued through October as well as clear bright weather. Under normal conditions the fall rains start in September, and especially in the coastal areas there is considerable cloudy weather. Early in October the Operating Committee critically

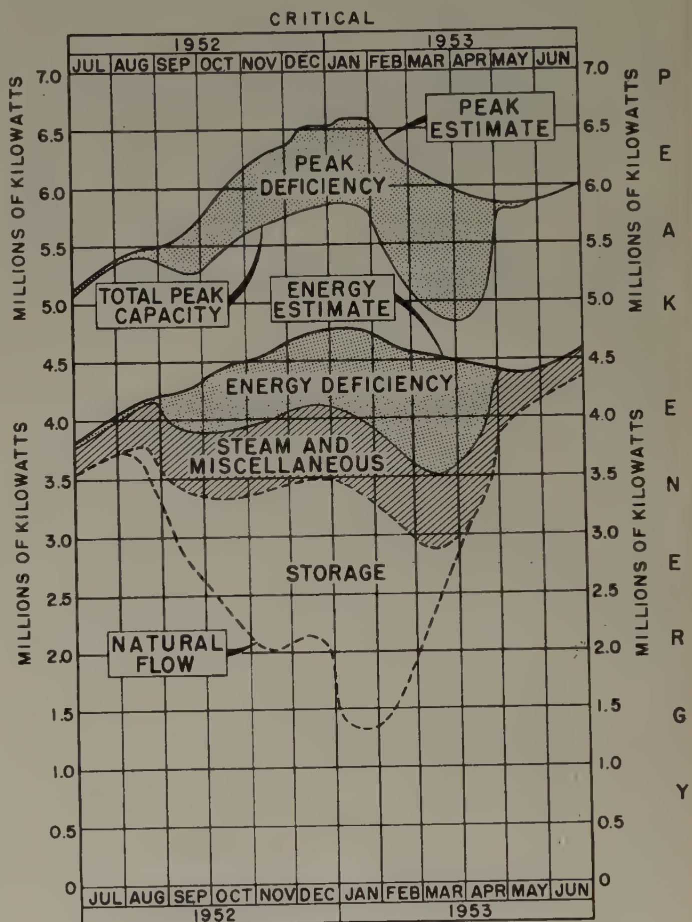



**Figure 1. Northwest Power Pool master chart. 1952–53 operating program. Estimated loads and resources with critical water**

reviewed the load estimates and the energy supply for the immediate future. Reservoir drafts had not been excessive and it was determined that if the very low natural flow conditions continued, firm loads could be carried through the week ending November 10.

Arrangements were made with owners of all types of generating equipment that could produce energy. These plants included small diesel-electric stations, sawmills, and industrial plants. Arrangements also were made with the United States Navy to start operation of a Navy Power Train, a 10,000-kilowatt steam plant built on railroad cars.

By the latter part of October it became evident that curtailment would be required. Reservoirs had been drafted below rule curves and estimates indicated an average deficiency of approximately 200 megawatts for the balance of the storage control season. With stream

**Table II. Western Group Average Natural Flow Resources in Megawatts for 1952**

| | Median Year | Critical Year | Actual 1952 |
|---|---|---|---|
| July | 3,212 | 3,231 | 3,197 |
| August | 3,294 | 3,286 | 3,157 |
| September | 2,844 | 2,556 | 2,496 |
| October | 2,360 | 2,007 | 1,953 |
| November | 2,575 | 1,645 | 1,482 |
| December | 2,450 | 1,688 | 1,532 |

**Table III. Comparative Precipitation July Through December 1952 for Representative Stations in Pacific Northwest**

| Station | Normal | 1952 | 1952 as Per Cent of Normal | Critical | 1952 as Per Cent of Critical |
|---|---|---|---|---|---|
| Revelstoke, British Columbia, Canada | 20.37 | 9.18 | 45 | 13.49 | 68 |
| Crescent Valley, British Columbia, Canada | 14.43 | 6.35 | 44 | No Record | |
| Kalispell, Mont. | 7.07 | 2.92 | 41 | No Record | |
| Spokane, Wash. | 7.66 | 4.30 | 56 | 5.06 | 58 |
| Grangeville, Idaho | 9.12 | 4.10 | 45 | 2.75 | 149 |
| Boise, Idaho | 5.05 | 1.50 | 30 | 1.69 | 89 |
| Seattle, Wash. | 17.49 | 8.97 | 51 | 11.28 | 80 |
| Portland, Oreg. | 19.17 | 9.57 | 50 | 10.96 | 87 |

flows continuing below critical flow levels, the overdrafting of the reservoirs was not in violation of the Principles and Procedures adopted by the Power Pool. These Principles state, "Reservoirs not to be drawn below Rule Curves except when: ...Actual natural flow is less than the corresponding critical flow with Rule Curves based on critical water. Such a condition is assumed to be temporary only." The difficulty in this instance was the "temporary" condition had lasted for 4 months and was continuing. Table II indicates the trend in natural flow for the Western Group of the Pool. Table III shows the lack of precipitation at representative locations in the drainage basins.

At the request of the Advisory Committee, DEPA issued Order *EO-4A*, "Limitation of Consumption and Deliveries of Electric Energy in Pacific Northwest" on October 29, 1952. The Advisory Committee further recommended a 10-per-cent cut in firm loads to become effective on November 17. It was estimated this would produce a 100-megawatt load reduction and voluntary curtailment might produce as much as 50-megawatt reduction. This level of curtailment did not meet the estimated deficiency and continued low stream flow would require additional firm cuts. It was decided, however, that it would be necessary to operate at this level until the amount of effective curtailment could be determined.

The area covered by the order did not include the Eastern Group as in that area the available power for export exceeded the capacity of the tie lines. Also excluded from the area was the portion of the Western Group in the Southwestern fringe area.

During the shortage, energy transfers from the Eastern Group were maintained at their maximum level around the clock. The British Columbia Electric Company drew heavily on their reservoirs to deliver energy to the shortage area. A block of Western Group load was disconnected from the Western Group and transferred to The California Oregon Power Company system, which produced the same effect as a transfer of energy north. It is not possible to operate interconnected with this system. The California Oregon Power Company operates interconnected with the Pacific Gas and Electric Company, and their interconnections with Pacific Gas and Electric Company and Bonneville Power Administration are not of sufficient capacity to permit interconnected operation of the entire Pacific Coast.

Mandatory curtailment resulted in an average reduction of 110 megawatts. This was determined from reports made by the consumers to DEPA. To estimate the total effect of the shortage is a difficult task. The measure of actual load carried is simple, but to arrive at an accurate figure of what load would have been carried if adequate resources had been available is very difficult, if not impossible. An attempt was made, however, and figures arrived at by using the November revision of load estimates and applying factors for temperature deviations. The results are shown in Table IV. The fact that load estimates for firm loads and actual firm load carried were in very close agreement shortly after the curtailment order was lifted indicates the estimate to be reasonable.

On January 7 there was a definite break in the weather and heavy rains were accompanied by mild weather. The recovery in natural flow resources was spectacular. Just prior to the Christmas holiday period the Advisory Committee had been seriously considering recommending an increase in the percentage for mandatory load curtail-

**Table IV. Western Group Average and Peak Loads in Megawatts**

*Showing adjusted and actual loads and computed load drop resulting from firm, interruptible, and voluntary load drop*

| | Average | | | Peak | | |
|---|---|---|---|---|---|---|
| Week Ending | Adjusted Load | Actual Load | Load Drop | Adjusted Load | Actual Load | Load Drop |
| Sept. 4 | 2,960 | 2,888 | 72 | 3,910 | 3,836 | 74 |
| 11 | 3,150 | 2,797 | 353 | 4,060 | 3,710 | 350 |
| 18 | 3,110 | 2,721 | 389 | 3,950 | 3,568 | 382 |
| 25 | 3,100 | 2,717 | 383 | 3,930 | 3,529 | 401 |
| Oct. 2 | 3,140 | 2,743 | 397 | 4,050 | 3,642 | 408 |
| 9 | 3,150 | 2,756 | 394 | 4,080 | 3,679 | 401 |
| 16 | 3,180 | 2,792 | 388 | 4,140 | 3,725 | 415 |
| 23 | 3,190 | 2,795 | 395 | 4,210 | 3,804 | 406 |
| 30 | 3,240 | 2,853 | 387 | 4,310 | 3,902 | 408 |
| Nov. 6 | 3,270 | 2,868 | 402 | 4,330 | 3,932 | 398 |
| 13 | 3,280 | 2,896 | 384 | 4,380 | 3,985 | 395 |
| 20 | 3,352 | 2,876 | 476 | 4,533 | 3,931 | 602 |
| 27 | 3,404 | 2,893 | 511 | 4,669 | 4,067 | 602 |
| Dec. 4 | 3,468 | 2,929 | 539 | 4,599 | 3,992 | 607 |
| 11 | 3,442 | 2,845 | 597 | 4,546 | 3,857 | 689 |
| 18 | 3,458 | 2,820 | 638 | 4,604 | 3,857 | 747 |
| 25 | 3,409 | 2,769 | 640 | 4,626 | 3,864 | 762 |
| Jan. 1 | 3,413 | 2,726 | 687 | 4,729 | 3,891 | 838 |
| 8 | 3,455 | 2,802 | 653 | 4,700 | 3,919 | 781 |
| 15 | 3,405 | 2,815 | 590 | 4,636 | 3,942 | 694 |
| 22 | 3,445 | 2,987 | 458 | 4,489 | 4,032 | 457 |
| 29 | 3,454 | 3,130 | 324 | 4,559 | 4,180 | 379 |
| Feb. 5 | 3,426 | 3,196 | 230 | 4,480 | 4,232 | 248 |
| 12 | 3,410 | 3,210 | 200 | 4,502 | 4,257 | 245 |
| 19 | 3,422 | 3,276 | 146 | 4,494 | 4,317 | 177 |
| 26 | 3,346 | 3,245 | 101 | 4,354 | 4,216 | 138 |
| Mar. 5 | 3,383 | 3,313 | 70 | 4,464 | 4,366 | 98 |
| 12 | 3,295 | 3,266 | 29 | 4,297 | 4,251 | 46 |

ment, but decided to wait until after the holidays. For the week ending January 1, natural flow capabilities were 1,484 megawatts. The following week, during which the rains started, the average increased to 2,031 megawatts. For the week ending January 15, it increased to 3,959 megawatts. In a 10-day period, the usable natural flow capability had increased 2,475 megawatts, or 167 per cent. Many streams had reached secondary flood stage and many of the plants were spilling water. The reservoirs all were rising and on January 13 the curtailment order on firm loads was revoked. On January 16, the prohibition for serving interruptible loads was revoked. The major portion of the firm loads was quickly restored; however, there is indication that conservation measures practiced by some of the customers have been continued. Restoration of interruptible loads was slower. The large portion of this load consisted of aluminum reduction and it takes time to put pot lines back into full production. By the middle of March most of the load had been restored.

System operation during this period did not present any unusual problems. The heavy continuous loads carried by steam plants caused higher than normal maintenance and some minor trouble, but no forced outages of any consequence developed. The length of the low-water period did permit maintenance work to be performed on a number of hydro units without sacrificing adequate reserve capacity.

The impact of the shortage and subsequent curtailment did not materially affect the economy of the region. It was estimated that 2,900 persons were unemployed as a direct result of curtailment of interruptible and firm loads. The light metal production agencies were the most affected with an estimated 2,350 of the unemployed.

Installation of additional generating facilities in 1953 assures the areas of sufficient capacity to meet all firm loads with a small excess for the present operating year.

# Safety in High-Voltage Testing

A. F. ROHLFS
MEMBER AIEE

T. BROWNLEE
MEMBER AIEE

**The well-rounded safety program described here includes electrical and mechanical safeguards, and a continuous education and inspection program by a very active safety committee.**

IN THE operation of a high-voltage laboratory, there exist two types of hazards: electrical hazards which can be broken down into those due to steady-state and impulse voltages, and nonelectrical hazards, such as working over large open oil tanks, servicing equipment at great heights, and lifting of materials. Naturally, during the construction of the test facilities of General Electric's new High Voltage Laboratory,[1] much thought was given to the elimination of both electrical and mechanical hazards. A safety system was instituted based on accident-free practices developed in the various high-voltage operations of the company.

The safety program consists principally of preventing laboratory personnel from injuring themselves or others. This is accomplished through the use of mechanical and electrical safeguards supplemented by thorough educational indoctrination at monthly intervals. The educational program is necessary because, unfortunately, the absence of accidents lulls the safety conscience of personnel working in hazardous areas. By continuous repetition and strict enforcement of the rules, personnel are reminded constantly to watch out for their own and their coworkers' safety.

The safety systems of any one laboratory or factory all should fall into certain patterns so that safe working procedures in one section are equally safe in another section. Workers should know in general how the safety devices work, and should be instructed in safe procedures and warned against unsafe practices.

## PROTECTION AGAINST ELECTRICAL HAZARDS

*Primary Safeguard—The Electric Gate Circuit.* To guard against electrical hazards, all test areas in the laboratory are enclosed with 8-foot-high grounded metal fences with gates for passage of personnel and equipment. At about waist height, flexible, 115-volt 2-conductor cables, equipped with plug and socket connectors, are attached to each gate and the adjacent fence. The flexible cables adjacent to the connectors are made short enough to prevent anyone from slipping through a gate before the circuit is opened. The fact that a conscious plugging-in operation must be performed to complete the gate circuit guards against accidental closure.

A small amount of test power may be taken directly through the gate circuit as shown in Figure 1; for greater power requirements, a system of relays and contactors is used as shown in Figure 2. The gate circuit, therefore,

Full text of paper 54-38, "Safety in High-Voltage Testing," recommended by the AIEE Committee on Safety and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 18–22, 1954. Scheduled for publication in AIEE *Transactions*, volume 73, 1954.

**A. F. Rohlfs** and **T. Brownlee** are both with the General Electric Company, Pittsfield, Mass.

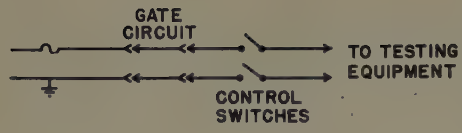



**Figure 1. Safety circuit for testing equipment with low power requirements**

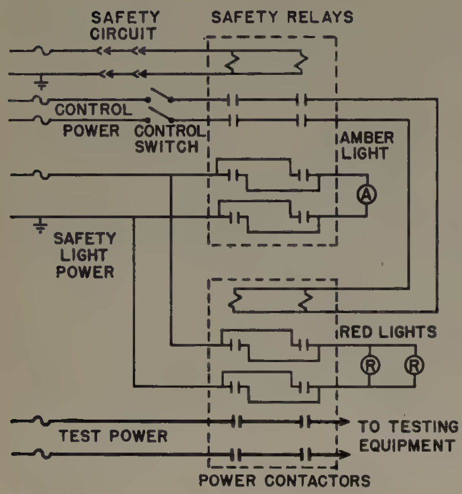



**Figure 2. Safety circuit using contactors and relays for testing equipment with moderate power requirements**

governs the safe operation of an area, and it is of the utmost importance that it does not cause wrong operation of the safety devices. If a short circuit or ground should develop in a gate circuit, it might by-pass the gate of an area. This is prevented by using a 2-wire grounded system and always carrying the two wires side by side through each gate plug, interlocking contacts, conduit, and so forth. Furthermore, the wires entering a gate are run in a different conduit from the wires leaving the gate. Short circuits or ground faults will cause fuses to blow and make the system fail safe.

*Safety Relays and Contactors* (*see Figure 2*). The safety features of the simple gate circuit of Figure 1 are self-evident because test power is removed automatically on opening the gate plugs. When using contactors, additional safeguards are required because of possible failure of these devices. As before, the gate circuit is used, but instead of supplying the test power directly, it controls the coils of two auxiliary relays in parallel. Series-connected contacts of these relays in turn permit a control switch to energize the parallel coils of the two contactors supplying the test power. Because relays and contactors are used in pairs, with contacts in series, there is a negligible chance that both will fail to open when the control switch or a gate is opened. Indicating lights are mounted so that at least one set is visible from every gate to an area. They are the sentinels which indicate failure in the safety and power circuits. Amber lights indicate that all gates to an area are closed and the red lights indicate that the test power contactors also are closed and a test is in progress. Trouble with a sticking safety relay is indicated when yellow lights remain on with a gate open and a sticking power contactor is detected when the red lights remain on after the control switch (or a gate) is opened. Needless to say, testing immediately stops when such irregularities appear in the indicating lights and is not resumed until the proper repairs have been made.

*Circuit Breakers and Disconnect Switches.* Circuit breakers are required to control the relatively large blocks of power used in 60-cycle high-voltage testing. Here, a safety circuit similar to the 2-contactor system of Figure 2 could be used. However, this would require the use of two breakers and would be expensive. To avoid this expense, a breaker and disconnect switch system is employed. The disconnect switch is installed near the area gate and is interlocked mechanically with the gate so that the switch can be closed only when the gate is closed completely, and the gate cannot be opened until the switch is opened. The disconnect switch is so positioned that it can be seen by the operator; thus, at a glance, he can make absolutely certain that the power is disconnected when he enters the area. Electric interlocks are provided to insure that the disconnect switch is closed before the breaker, and the breaker is opened before the disconnect switch. As in the case of the contactor application, auxiliary relays controlled by the gate circuit are used to permit application of control power to the circuit breaker coils, and the system of amber and red lights provides a visual indication of the safety circuit and circuit breaker operation.

Such a system works well with areas that have but one gate. For areas with more than one gate, mechanically interlocked disconnect switches could be installed on each gate. However, this becomes awkward and expensive, and results in long cable runs which may interfere with accurate testing, particularly if the area is large and the gates widely dispersed. In such cases a motor-operated disconnect switch is used. This is electrically interlocked with the gate circuit by means of double safety relays with the coils in parallel and the contacts in series as previously explained. Again, the disconnect switch is positioned so as to be seen easily by the operator so that he can check when entering the test area.

*Interlocking of Test Areas.* One of the prime rules of high-voltage testing is *never* to bring test wires from one area to another without special precautions. To accomplish this in a safe way, the gate circuits of the two areas are interlocked as shown in Figure 3. A master switch, when set on the proper position, connects the gate circuits of the two areas in series, connects all of the safety relays of the two areas to the end of the series-connected gate circuits, and connects the auxiliary lights of the two areas in parallel. Thus, opening a gate to either of the two areas will make the test power in both areas inoperative.

The sequence of area interlocking, running of leads between areas, and checking of gate circuit operation is carefully controlled and supervised by a dispatch system. Before any wires are connected between areas the test man must obtain a permission slip, signed by two authorized persons, who previously have interconnected the safety circuits of the two areas and have tested them for proper operation. After the test wires have been installed between areas, the setup must be inspected and approved by the two authorized persons before power can be applied. Before the safety interconnection is removed, inspection is made to assure the removal of the test wires between the areas in question and a signed statement to that effect

is filed. Only wilful neglect on the part of an area operator could circumvent such a system.

*Safety in Test Areas.* In a laboratory where only one test area is in use and only one or two persons are involved, the safety circuits described provide complete protection because these operators are mutually responsible for each other and will know at all times whether the area is clear for testing. The problem becomes much more complicated where many test areas involve a large number of people who may have reason to enter areas other than their own. It is obvious that safety gates and circuits cannot protect a man once he is inside of an area unbeknown to the area operator. This problem has been handled by strict exclusion of *all* personnel from test areas other than their own. The names of the operators are posted at the area gate by their supervisor. These men have free access to the area at all times but are mutually responsible for each other and are forbidden to close the gate circuits unless they *know* all members of their crew are outside the area. All others are forbidden to enter the area unless they ask to be escorted by a crew member or unless the area is completely shut down, high-voltage equipment grounded, and a "Do Not Operate" tag attached to the plug of the gate circuit. Over 2 years' experience shows the system to operate effectively, and the men accept the idea of exclusion as necessary for their own safety.

Within the test areas, attention must be given to the specific testing equipment. Impulse and d-c generators with their many banks of capacitors are especially dangerous if not properly protected. Solenoid-operated ground switches are located at the high-voltage output side of the rectifier used to charge the generator. These ground switches open to remove the ground from the rectifier at the beginning of the charging cycle. When the generator is shut down either from the control panel or by opening a gate, the ground switches close by action of gravity, thus discharging the capacitors of the generator. That is, the capacitors will be discharged providing the charging resistors between banks are all in good condition. Since this may not be the case always, the testing personnel are taught always to ground the nearest high-voltage test lead when they first enter an area. Such grounding is accomplished with ground sticks which consist of a hook on the end of an insulated pole, the hook being connected to a nearby ground through a copper braid. Thus, the man does not have to touch the grounding conductor.

Similar ground sticks also are provided at the base of each impulse generator so that the lower banks can be grounded when one must work near the generator. Here special care is necessary for it is not sufficient to ground just one terminal of several capacitors connected in series, nor is it sufficient momentarily to ground the terminals one at a time. The capacitors still will retain some charge. Impulse generator stages frequently are constructed with two or three capacitors in series. The safe practice is to short-circuit and ground all terminals. Each generator is provided with a ground rig to accomplish this. In the large 5-megavolt generators, grounded steel tapes are pulled, with leather leaders, through contacts on each capacitor terminal. In the smaller impulse generators a device is mounted on each capacitor and is arranged so that movement of a central mechanism short-circuits each capacitor. Whenever a man must work on the generator itself, these grounding rigs are used to short-circuit and ground the capacitors.

Where areas are in close proximity, it is permissible for one person to operate an area providing there are other operators nearby. It is mandatory for two persons to operate an isolated area so that if one of them were hurt, the other would be on hand to administer first aid or get help.

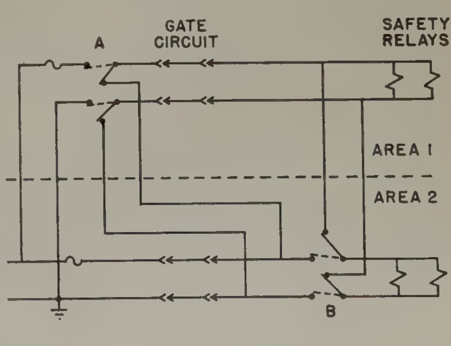
*Metering, Control, and Measuring Circuits.* Leads may not be run out of a test area unless they are contained in a grounded sheath and terminate in a protected enclosure. Meter connections and the deflection cables running to cathode-ray oscillographs fall into this category. Voltmeters and other instruments, which are changed regularly by test men, are placed in a metal compartment with a glass window. Interlocks are provided to interrupt the power source if the compartment cover is raised. If portable meters are connected into high-voltage circuits, they are located within the test area and read through the fence, or, with the approval of a safety committee member, meters can be located outside the area, provided the meter and leads are enclosed completely in a grounded metallic shield and conduit.

In the case of 115-volt shop power circuits, which may supply outlets in more than one area, the transmission of dangerous voltage surges from one area to another is prevented by grounding one side of the circuit solidly, and by protecting the other side with Thyrite* resistors, both at the supply transformer and at each area. The Thyrite is connected directly to the line without a series gap but draws only a few milliamperes at normal voltage. Its nonlinear characteristic prevents excessive voltage even when discharging hundreds of amperes. Similarly, Thyrite is used on all control circuits in the area and in the control station. Not for reasons of safety, but to preserve their life, all overhead lights are protected by Thyrite to guard against the effect of the high surge currents during impulse generator discharge.

*Safety Tags.* Throughout the plant, round red tags are used by maintenance workers to prevent the operation of switches, valves, or other mechanisms to which the tags are attached. Only the person who signed the tag can remove it. This has proved to be a safe method. A

* Registered trade-mark of the General Electric Company.

**Figure 3. Interlocking of two test areas to operate as one area with switch positions as shown by solid lines at A and B. Dotted lines refer to independent operation of areas**



slightly different square red tag is used in the high-voltage laboratory to indicate that the area has been made safe for anyone to enter and to prevent energizing of the area equipment until the tag has been removed. It is the responsibility of the man whose name the tag bears to see that all power switches are turned off, high-voltage transformer terminals grounded, and impulse generator capacitors short-circuited and grounded before the tag is placed. It is also his responsibility to make sure the reasons for tagging no longer exist and no one is in the area before the tag is removed. The tag is attached to a gate plug and its presence allows laboratory personnel free access. It also permits entrance by maintenance men and visitors after permission has been granted. Normally, this tag can be removed only by the signer. However, in his absence, two others who are authorized to use the tags may search the area jointly and after assuring themselves of safe conditions, may remove the tag.

*Temporary Safety Areas.* Occasionally, it is necessary to use a temporary enclosure. If there is no practical way of doing the work in a permanent test area, a temporary area can be arranged under the guidance of the laboratory's safety committee. Portable fence sections, equipped with gate circuits, can be plugged together to form an interlocked enclosure. Safety committee approval is required before such an area can be put into use.

In a few cases where it is impractical to use fence sections, temporary enclosures can be made, using red-striped white tape strung on poles. It is not permissible for such tape to be used for any other purpose. "Danger—High Voltage" signs are attached to the tape. No one is permitted to pass over, under, or through the tape, until the tests are completed, the power shut off, and the tape completely removed. Such temporary areas are kept to a minimum and are used generally for relatively low voltage measurements, such as with the Schering bridge.

*Low-Impedance Grounds.* In a high-voltage laboratory, grounds and ground connections should be low in inductance as well as resistance. The all-steel construction of the laboratory with frequent bonding between the reinforcing steel in the floor and the building columns makes low-impedance ground connections available anywhere on the walls, ceilings, floors, or supporting columns. The safety fence footings consist of inverted steel channels flush with the floor and welded to the floor reinforcing grid. The building is surrounded by a 500,000-circular-mil cable imbedded in the soil and connected to building columns and 16 10-foot driven ground rods. Many pipes, which are bonded to the building, furnish additional low-impedance contact to the surrounding earth. Separate counterpoise grounds and ground rods are available in all test areas to improve accuracy in measurement of steep front impulse voltages and they make the over-all grounding still more effective.

*Grounding Technique.* High-voltage impulse generator circuits require considerable clearance and the test areas are necessarily rather extensive. The currents, especially when test specimens flashover, are high and have steep fronts so that many kilovolts drop may occur on the conductors which carry these currents. New men must be educated on proper grounding techniques to make sure that ground connections to all other devices in the test area do not carry any of the impulse current which flows in the ground conductor between the test specimen and the impulse generator. The same precaution holds for work with high-voltage testing transformers which have considerable distributed capacitance from high-voltage lead to grounded tank.

*Alternator Power Dispatching.* The testing transformers in six test areas are supplied by three alternators with field control of the excitors available at the control stations. The alternators are 3-phase Y connected but, except for unusual conditions, such as the 3-phase arc demonstration, the loads are single phase. Each alternator has three coils per phase which are brought out to a terminal board so that series or multiple connections can be made. The access gate to each terminal board is mechanically interlocked with the deadfront alternator field switch so that the field windings cannot be energized when the gate is open.

To prevent the simultaneous application of power from one alternator into two areas or to prevent simultaneous feeding of power from two alternators into one area, "Kirk" locks are used in the feeder cubicles for the magne-blast circuit breakers. Several adjacent cubicles are connected in parallel to an alternator on the incoming side and the outgoing conductors of each cubicle supply a specific area. Two Kirk locks in each cubicle prevent the use of a breaker in a cubicle unless both locks contain a key. There are identical lower locks in every cubicle supplied by a specific alternator and identical upper locks in each cubicle which supplies a specific area. Since there is but one key per alternator and one key per area, the desired objectives are realized. Auxiliary contacts on each breaker transfer the field and other controls to the area associated with the particular cubicle being used.

## PROTECTION AGAINST NONELECTRICAL HAZARDS

There are several nonelectrical hazards that deserve special attention. Much of the testing is performed on specimens which are submerged in oil in large tanks. Frequently these are open at the top for setup and observation purposes. Great care must be exercised by the people working around the top of the tank since the density of the oil is not sufficient to float a person. To prevent anyone from falling into the oil, a safety harness is used. It is secured by a length of heavy rope to an elevated point in such a manner that should a person fall, his head and shoulders could not go beneath the surface of the oil.

Occasionally it is necessary to suspend components of high-voltage circuits from the roof or wall by means of ropes. If corona develops where the rope is attached to the circuit component, the rope may be charred and weakened to the extent that it will break and drop the load to the floor. To avoid this danger, insulating rods or tubes are inserted between the circuit components and the rope, their length depending upon the magnitude of the voltage involved.

Work on the upper parts of the impulse generators or on elevated testing circuits is performed from a bosun chair equipped with a safety belt as shown on the cover.

Metal scaffolding, which can be wheeled from point to point, is used to work at moderate heights. This has the advantage of greater stability and more working freedom than tall stepladders.

The usual accepted practices with regard to general safety measures are followed. Lift trucks and cranes are provided for movement of equipment and materials. The wearing of safety glasses throughout the entire laboratory is encouraged and is mandatory in the workshop. Because of the presence of oil, smoking is prohibited within the test areas. Oily rags are disposed of in special containers and slippery conditions caused by spilled oil are cleaned up as soon as possible using Fuller's earth.

### SAFETY COMMITTEE ACTIVITIES

A GOOD SAFETY PROGRAM naturally requires considerable thought in drawing up sensible easily understood rules and persevering diligence in seeing that the rules are followed. While all laboratory personnel are expected to be "safety conscious" and to suggest improvements or to correct violations, it is the job of the safety committee to promote the program energetically. The committee consists of several carefully selected persons who are completely familiar with the laboratory equipment and problems to be solved in operating the equipment in a safe as well as efficient manner.

The chief activities of the safety committee are as follows:

1. Formulation of safety rules.
2. Instruction of new personnel.
3. Periodic inspection with recommendations for needed changes.
4. Performance of certain operations prohibited to other personnel.
5. Co-operation with local and other General Electric safety groups.
6. Conduction of monthly resuscitation drills using the back-pressure arm-lift method.
7. Solicitation of safety suggestions.
8. Continuous inspection for and correction of unsafe practices.

Item 8 often is the hardest of all since it is difficult for many persons to accept reasons for certain safety practices, in view of the excellent safety record enjoyed by the laboratory. A potentially fatal accident seems to be the only way to convince them. For example, some men felt a safety harness was unnecessary when walking around open oil tanks. This objection was quickly withdrawn after one man slipped into the oil up to his shoulders and only the safety harness prevented complete immersion.

### SUMMARY

A WELL-ROUNDED safety program is indispensable in a high-voltage laboratory. Electrical and mechanical safeguards are employed to prevent personnel from coming in contact with live circuits. A continuous program of education and inspection is carried on by a safety committee to make certain that personnel understand the safety systems and that the safety devices remain in good working order. Area operators, in particular, must be taught and encouraged to be vigilant. They also are encouraged to be alert for new methods to save time and effort, but never at the expense of safety.

### REFERENCE

1. New High-Voltage Engineering Laboratory, **J. H. Hagenguth.** *General Electric Review* (Schenectady, N. Y.), September 1949, page 9.

# Speed-Variator Log-Carriage Drives for Small Mills

A new line of speed-variator log-carriage drives featuring easy installation, finger-tip control, packaged power, and high drive efficiency has been announced by the General Electric Company.

Engineered to meet the carriage-feed requirements of small and semiportable mills, the new speed-variator units are available in drive ratings of $7^1/_2$, 15, 20, and 30 horsepower for either 220- or 440-volt power supplies.

The new drives use essentially the same electric circuit as the company's larger log-carriage drives and also have the same desirable features of amplidyne control for easy adjustable speed with smooth, rapid acceleration and deceleration. The flexible amplidyne control system eliminates such mechanical devices as brakes, clutches, and differential gears.

The sawyer completely controls the movement of the carriage by means of the operator's switch to give continuous speed adjustment from zero to maximum.

Each complete speed-variator log carriage drive includes a driving motor, a packaged power unit, an operator's master switch, two overtravel limit switches, and a push-button station. The power package contains a 4-unit motor-generator set, an amplidyne control panel, an a-c motor control, and d-c line contactor and dynamic braking resistors enclosed in a single self-supporting panel.

The drives use regenerative braking for normal carriage stops whereby carriage energy is pumped back into the power lines instead of being wasted in heat by normal braking methods.

An added safety factor is provided by overtravel limit switches near each end of the carriage track which automatically bring the carriage to a stop if the operator does not stop it before it reaches the end of the track. Other safety features include thermal overload relays to protect the a-c motor and the d-c motor and generator, and current limiting fuses for short-circuit protection of the entire drive.

# Direct Cooling of Turbine-Generator Fields

C. H. HOLLEY
MEMBER AIEE

H. D. TAYLOR
FELLOW AIEE

A MAJOR IMPROVEMENT in the cooling of field windings of turbine generators has been developed by the General Electric Company and applied for the first time in a 125,000-kva (30-pounds-per-square-inch-gauge hydrogen pressure) 3,600-rpm turbine generator now in the Huntley Station of the Niagara Mohawk Power Corporation at Buffalo, N. Y. Figure 1 shows the field of this machine. The new cooling arrangement has been proved successful in factory tests, which showed that at full 30-psig capacity, the temperature rise of the field winding is only about 25 per cent of that of otherwise duplicate fields of standard design previously tested. This indicates that for the same temperature rise, the new field could have its 30-psig capacity doubled, to 250,000 kva. Because of a requirement that the generator field be interchangeable with the fields of several previous machines of the same capacity, it was not feasible to take advantage of the improved cooling to reduce the physical size of this particular generator.

The new cooling system applied to this field is an application of an old idea, originated long ago and repeatedly revived by successive generations of designers, whereby the cooling gas washes the heat resulting from the $I^2R$ loss directly off the winding copper, rather than indirectly from the steel rotor body after the heat flows through the coil insulation into the steel. This direct cooling eliminates the temperature difference across the insulation, from copper to steel, which long has been known to be the major component of the temperature rise of the winding. Various practical difficulties have delayed the application of direct cooling to turbine generators in the United States, including the problem of clogging of necessarily small ventilating passages by dirt, or by frayed or displaced insulation; and the problem of providing access to the winding for the direct flow of cooling gas without weakening the insulation level of the winding, particularly with respect to creepage paths. One of these problems has been solved by the inherent cleanliness of modern hydrogen-cooled generators, and the others by the development of improved forms of insulation, and by careful design based upon extensive developmental tests.

**Figure 1. Direct-cooled field of 125,000-kva 3,600-rpm turbine generator**

A unique feature of the direct cooling system developed at Schenectady, N. Y., is that it employs a multicircuit flow path in the rotor quite similar to the multi-inlet system long used in the stators of large turbine generators. In other words, the cooling gas enters the rotor not only axially from both ends, but also radially at several intermediate points. This involves the use of scoop devices flush with the rotor surface, to pick up cool gas from the air gap between rotor and stator. The impact head from the scoops is used to create a strong flow of gas into each winding slot through forward-slanting holes in the wedges and teeth, then axially through passages inside the individual turns of the winding, and finally out to the air gap again through backward-slanting discharge holes. The rotor inlet scoops line up approximately with the stator core inlet ducts, and the rotor outlets with the stator outlet ducts, so that recirculation is avoided.

Exploitation of direct cooling in generator fields is making possible the building of much larger ratings than were previously possible in single generators within the space and weight limitations already established for more conventional designs, as well as a considerable reduction in dimensions and weight for ratings previously achieved. The advance in field output is so great, however, that a corresponding advance in stator output is required also. This can be done in a variety of ways, such as: by one of the low-voltage types of design described in a companion paper;[1] by direct gas-cooling of the armature; or by liquid cooling, as is being done in a 260,000-kva 3,600-rpm generator now under construction. Two limitations appear, however, as drawbacks to any extreme exploitation of direct cooling: high excitation, of the order of two or three times normal, or more; and increased losses (corresponding to the increased heat removed by the more effective cooling), usually resulting in some decrease in generator efficiency. Both of these effects increase sharply with the degree of "rate-up" employed in direct-cooled designs relative to conventional designs in the same basic dimensions.

REFERENCE

1. New Developments in Armature Winding Arrangements for Large Turbine Generators, **Dean Harrington, J. E. McElligott.** AIEE *Transactions*, volume 73, 1954.

Digest of paper 54-49, "Direct Cooling of Turbine-Generator Field Windings," recommended by the AIEE Committee on Rotating Machinery and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 18–22, 1954. Scheduled for publication in AIEE *Transactions*, volume 73, 1954.

**C. H. Holley** and **H. D. Taylor** are with the General Electric Company, Schenectady, N. Y.

# Summary of Preliminary Report

## Committee on Evaluation of Engineering Education

**Foreword.** The summary presented here is that of the Preliminary Report prepared by the Committee on Evaluation of Engineering Education of the American Society for Engineering Education (ASEE). The work of this committee over the past 18 months has been financed jointly by Engineers' Council for Professional Development (ECPD) and by the Engineering Foundation. The Preliminary Report now is being studied by institutional committees on evaluation in some 150 colleges of engineering. When the comments and criticisms from the educational institutions are received, the Preliminary Report will be revised and presented to the ASEE.

At the request of the ECPD Education Committee, which is responsible for recommending accreditation of engineering curricula, the Preliminary Report not only attempts to evaluate the factors that contribute to high quality in engineering education, but it offers for consideration several suggestions concerning the subject of accreditation. These suggestions have drawn considerable criticism from educational sources. Hence, it seems well to point out that the suggestions on accreditation have not been accepted finally by the Committee on Evaluation, but were presented to bring forth discussion and analysis by the engineering schools and by any other interested source in the engineering profession. Comments will be welcomed; they may be directed to Professor D. H. Pletta, the secretary of the Committee on Evaluation, at Virginia Polytechnic Institute, Blacksburg, Va.

Of course, accreditation is the function of ECPD. Therefore, any discussion of accreditation by the ASEE Committee on Evaluation of Engineering Education can be only an expression of opinion, which is being clarified through the comments now being received. Educational recommendations from the final report when accepted by the Council of ASEE will be passed on to the colleges of engineering for their voluntary use in the improvement of engineering education. *L. E. Grinter*, president, ASEE

THE COMMITTEE on Evaluation of Engineering Education was appointed in May 1952 by Dean S. C. Hollister, then president of the ASEE. The charge to the committee was to determine the pattern or patterns that engineering education should take to provide the leadership that the profession must have 25 years from now. It had become evident that the tremendous strides taken in the physical sciences during the past decade had begun to influence requirements being placed upon the profession of engineering while only minor adjustments have occurred in engineering education.

As examples of the increased importance of the basic sciences in engineering progress one can point out that electronic developments have demanded greater knowledge of physics from electrical engineers. Such problems as continuity between structural members produced by welding and problems of vibrations of suspension bridges have demonstrated the need for greater scientific background for civil engineers. Mechanical engineers found new fields for research in heat transfer, fluid mechanics, and later in jet and rocket propulsion. Practical metallurgy has changed from an art to a science based upon physical chemistry and physics of the solid state. The need for new reactor materials, new nuclear-thermal processes, and new materials and systems for radiation protection add to our picture of the increasing influence of science upon engineering practice. Hence, even without considering the major changes that are inevitable in engineering as nuclear power becomes available, we conclude that the many developments of the past 10 or 15 years inevitably would necessitate major changes in the character of engineering education.

From another direction there comes an even greater influence upon education in engineering. Since 1940 a large percentage of research physicists have had their interests reoriented toward nuclear problems, and it seems doubtful if the interest ever will be returned in sufficient measure to influence greatly the research in vibrations, elasticity, plasticity, heat transfer, engineering thermodynamics, fluid flow, and the other engineering sciences. Hence, engineers have become responsible for the continuity of research in all the fields of engineering science. The leaders of the engineering profession 25 years hence must be engineers who are at no loss in interpreting or themselves contributing to the extension of the fields of engineering science. Typical curricula of the 1910–1940 era were not designed with such an objective in mind.

### CURRICULA CONSIDERATIONS

*Basic Science.* The basic sciences for all engineering curricula include mathematics, physics, and chemistry. Mathematics through ordinary differential equations seems close to a minimum essential for all engineers. Chemistry deserves increased emphasis in engineering education and for a larger proportion of engineers considerably more than the usual freshman chemistry course is necessary. The committee, on three occasions, has indicated its belief that modern physics, including nuclear and solid-state physics, has become an essential study in engineering. Since the physicists' teaching of mechanics, thermodynamics, and electricity is at least partly duplicated in engineering courses, it is believed that better co-ordination would provide opportunity for the study of modern physics. The committee, therefore, recommends greater emphasis upon basic science in engineering curricula.

*Engineering Sciences.* The committee has recognized nine important background sciences in engineering.

Personnel of the Committee on Evaluation of Engineering Education: L. E. Grinter, *Chairman;* D. H. Pletta, *Secretary;* H. H. Armsby, M. M. Boring, G. G. Brown, A. B. Bronwell, R. S. Burington, J. F. Calvert, A. P. Colburn, C. S. Crouse, N. W. Dougherty, T. H. Evans, R. C. Ernst, D. F. Gunder, G. A. Hawkins, H. L. Hazen, P. Hemke, J. A. Hrones, L. H. Johnson, J. H. Lampe, F. C. Lindvall, J. Marin, G. Murphy, M. P. O'Brien, R. L. Pigford, J. H. Rushton, T. Saville, R. J. Seeger, H. H. Skilling, R. L. Sweigert, K. F. Tupper, E. A. Walker, E. Weber, H. E. Wessman, W. C. White, C. L. Wilson, W. R. Woolrich, D. Young. Cochairmen of the four subcommittees: L. M. K. Boelter, W. L. Everitt, S. C. Hollister, B. R. Teare.

They are statics; dynamics; strength of materials; fluid flow; thermodynamics; electric circuits, fields, and electronics; heat transfer; engineering materials; and physical metallurgy. It is believed that all of these studies should be represented in curricula that train engineers for service in research, development, or design, and probably no fewer than seven should be integrated into every curriculum that is represented as education for engineers.

*Analysis, Design, and Engineering Systems.* Such studies of the junior and senior years, along with the necessary background of the engineering sciences, represent the features that distinguish engineering education from education in science on the one hand or technical institute education on the other. In all curricula except those intended for training in management or other general professional service, studies in design, or in analysis leading to design, should occur as an integrated study over four successive semesters. Even the most general curricula should include such studies as a continuing program for at least two semesters.

*Nondepartmental Engineering Courses.* Curricula often contain certain engineering courses selected for broadening purposes such as electrical engineering for nonelectricals and heat engines for nonmechanicals. When given, such courses should limit the study of special machines or devices including their construction, production, or operation. The committee affirms its conviction that the most important broadening courses in engineering are those listed as the engineering sciences.

*Humanistic-Social Studies.* The committee recognizes the importance of social studies and the humanities as an important part of an engineer's education. Such studies reveal the richness of human experience so that students in turn may enrich their own lives. They should trace the political, economic, and social history of mankind to give students a clearer perspective of our civilization today. They should provide inspiration for seeking greater knowledge and understanding. They should aid the student to develop judgment and discrimination, a sense of value, and a sound personal philosophy.

The seeking for immediate usefulness in the social studies and humanities, as tool subjects in engineering, well may lead to failure to achieve the aforesaid objectives. Such courses as accounting, industrial psychology, investment economics, comparative costs, or city management may be just as technical as engineering studies. It is outside of such fields that the social-humanistic studies must lead the student. The committee recommends a much broader study of the effectiveness of the social-humanistic stem of engineering education.

## FACULTY SELECTION AND DEVELOPMENT

Since a more scientific approach to engineering education is needed it will be essential to improve the scientific background of engineering faculties. Within a given faculty there should exist a balance of experience in both the science and art of engineering. An educational background which includes the doctor of philosophy degree is the strongest evidence usually available to measure the probable usefulness in teaching and research of a relatively young candidate for a faculty position. For older persons evidence of the productivity of the individual in creative teaching and research can be gauged by other criteria, and the formal educational background is of less significance.

Engineering education cannot develop superior students without developing superior teachers who will be recognized as creative leaders in the fields in which they teach. A faculty that can be expected to provide adequate leadership for students will have at least one member in five who has achieved professional distinction by creative activities. Such persons will be conducting high-grade research of an engineering or educational nature or other creative activity including publishing of good quality; engaging in consulting work at a creative level; exercising leadership in scientific, educational, and professional societies; or, preferably, serving in a combination of such activities. It is recognized that development is quite as important as selection of a faculty and also that a definite policy on termination of employment for those who do not live up to their expected performance is a necessary factor in faculty development.

## ACCREDITATION OF CURRICULA

A request from ECPD brought the Committee on Evaluation into the discussion of accreditation. For proper handling of accreditation, ECPD needs improved standards for measuring the effectiveness of the educational process and also criteria that distinguish engineering curricula from those in science and from those in technical institutes. As already indicated, the Committee on Evaluation concluded that an increased background in mathematics, physics, and chemistry, a study of nine engineering sciences, and a continuity of study of engineering analysis and design, or of engineering systems, extending through four semesters should distinguish an engineering curriculum intended for the training of engineers for professional-scientific service such as research, development, or design. Then recognizing the need for additional engineers for general professional engineering services, the committee concluded that a bifurcation in engineering education is the practical answer to such diverging functional objectives. Therefore, it has devised the terms "professional-scientific" education and "professional-general" education to designate the two broad functional objectives of engineering education.

Professional-general education is that designed for producing engineers qualified (1) to serve in areas between engineering and business, management, law, real estate, or agriculture; (2) between engineering and a branch of science where the opportunities to apply engineering analysis and design may be limited; (3) between engineering and a highly applied technology such as production processes, operation, construction, or air conditioning, welding, or wood technology. Such programs may have somewhat reduced requirements of mathematics, physics, and chemistry, and only seven of the nine engineering sciences need be included. Also, the study of engineering analysis and design may be reduced from four to two

continuous semesters. However, the decision as to whether a planned program is really engineering education is to be made wholly upon its content of the engineering sciences and the use made thereof in the study of engineering analysis, design, and engineering systems.

A decision has been reached by ECPD, upon the recommendation of the Council of ASEE, that the standards of accreditation of engineering curricula shall be raised. To achieve this result without undue hardship, it is here recommended that the accreditation process be reconsidered on the basis of a distinction between professional-scientific studies and professional-general studies. Some institutions may choose one function or the other for all programs; other institutions may have a bifurcation between the objectives selected by different departments; and in large departments dual curricula serving different functions may develop. The Committee on Evaluation recommends that each engineering college determine for itself the best way to meet either or both of the dual objectives that the committee has defined for engineering education. To ECPD it recommends liberal acceptance of experimental programs that meet the definition given of engineering education, that is, those that include an adequate content of engineering science and of applications thereof to engineering analysis and design. The length of curricula should be one such factor subject to wide experimentation. The committee does foresee difficulty in meeting within a 4-year program its recommendations for an accredited professional-scientific engineering program plus all of the specialized courses of the degree-granting department, but it believes that specialized engineering courses are of far less value in professional-scientific education than a broad background of engineering science and its application in one field of analysis and design.

### SPECIAL DESIGNATION OF ACCREDITED CURRICULA

There appears merit in identifying those curricula which meet criteria substantially above the minima. The major factor in such identification should be the background and eminence of the faculty and its attention to creative teaching. When the program conducted by this faculty is of such a nature as to develop in a considerable proportion of the graduates a capacity for creative technical activity or creative leadership in engineering it is the recommendation of the committee that this curriculum should be given special designation. For such designation curricula should be taught by faculties including a substantially larger proportion of distinguished staff members, as defined previously, than is required for minimum accreditation. The recommendation of a curriculum for special designation should be referred by the Inspection Committee for final action to a group of national representatives whose background of examination of institutions covers a wide geographical area.

### CONCLUSIONS

1. By joint action of ASEE and ECPD the Education Committee of ECPD has been instructed to develop higher standards for accreditation of engineering curricula.
2. One objective of the Committee on Evaluation has been to establish a philosophy of engineering education appropriate to the training of engineers for leadership a generation hence, and to clarify the significant factors that contribute to high standards of engineering education.
3. Another objective has been to study the influence of higher standards of accreditation upon the engineering colleges and to consider ways in which institutions appropriately may justify accreditation based upon the performance of different functions in the broad field of engineering education, if they so desire.
4. The functional divergence so evident in engineering activities, which range from research to management and sales, has led to the committee's recommendation that accreditation be based upon either of two defined functions in engineering education, that is, professional-general education and professional-scientific education. Such divergence should not necessarily require separate curricula but might be based upon options, groups of electives, thesis study, and so forth.
5. In order that the decision to develop advanced standards of accreditation may not unduly restrict the number of possible accredited curricula, the committee recommends that a special designation be given to any curriculum taught by a faculty of unusual distinction where the program conducted by the faculty is of such a nature as to develop in a considerable proportion of the graduates a capacity for creative technical activity or creative leadership in engineering.

### FURTHER STUDIES

The Committee on Evaluation has made the report as summarized in the foregoing as a "Preliminary Report" for study by each college of engineering. Each of the recommendations tentatively adopted will be reconsidered in the light of the suggestions, criticisms, and revisions presented by reports from institutional committees on evaluation and deans of engineering colleges. Resolutions from engineering groups will be welcomed although mere criticism or approbation without supporting analyses will not be very helpful to the committee in revising its report into final form. Therefore, the Committee on Evaluation particularly requests thoughtful, mature analyses of the "Preliminary Report" without undue emphasis upon the form or mechanism of accreditation which is of secondary importance in this study.

## Standards for Radio Panels

Standards for aircraft radio panels and for the cavities in which they are installed have been recommended by the Radio Technical Commission for Aeronautics.

Primary objectives are to provide adequate space in aircraft cockpits for locating radio controls so as to be readily accessible to pilots and to improve efficiency of operation. Standardization also will facilitate the initial design of radio control panels, their installation, and maintenance, modification, and replacement.

# Kemano-Kitimat Hydroelectric Power Development

F. L. LAWTON
FELLOW AIEE

THE NECHAKO-KEMANO-KITIMAT hydroelectric power development and the power-consuming aluminum-reduction plant, at Kitimat, of the Aluminum Company of Canada, Ltd., the Canadian production subsidiary of Aluminium Limited, are located in the Coast Range country of British Columbia, with water access about 500 miles from Vancouver and 180 miles from Prince Rupert.

Kenney Dam, the third highest rockfill dam in the world, creates a storage reservoir with a total capacity of 20,000,000 acre-feet, which is sufficient to provide a regulated flow of 6,920 cubic feet per second, under a net head of about 2,500 feet. Diverted through two (one initially) 25-foot-diameter 10.1-mile power tunnels and pressure conduits to an underground powerhouse, the flow generates an estimated 1,718,000 horsepower.

Sixteen vertical, single-runner, 4-nozzle, impulse turbines, each rated at 140,000 horsepower with an expected output of 150,000 horsepower, are being housed in a chamber excavated from the solid rock of the mountain mass, about 1,400 feet in from the face of the mountain. This chamber, of which only half is to be excavated in the initial stage, ultimately will be 1,135 feet in length, 81 feet in width, and 134 feet in height. With an installed capacity of 2,240,000 horsepower, Kemano generating station will be the largest underground power plant in the world.

The vertical generators are rated 60 cycles, 327 rpm, 13,800 volts, 0.8 power factor, 106,000 kva, at 60 degrees centigrade temperature rise, and 122,000 kva at 80 degrees centigrade, capable of continuous operation at the higher rating. Each generator feeds one primary of double-primary transformer banks rated at 213,000 kva with one cooler operating and 285,000 kva with two coolers. These transformers, which are housed in the generating station, step the voltage up to 300 kv, the output of each bank being fed to the switchyard over 300-kv power cables. The transformers are not provided with winding taps and the neutral on the high-voltage side is solidly grounded.

In the initial stage, only three generating units are to be installed. The turbines, generators, and transformer banks are being supplied by separate manufacturers, and it is anticipated very significant performance data will be secured. One manufacturer is supplying 300-kv power cable with an aluminum conductor and an aluminum sheath, whereas the other is furnishing a more conventional design.

Station service is provided by 2,500-kva water-cooled transformer banks tapped from the generator busses and so interlocked on the 550-volt secondary side that neither generators nor main transformer banks can be paralleled through them.

Station relaying includes split-phase and differential protection for the generators, transformer differential and gas-detector protection of the type which has demonstrated its reliability and value on a number of Canadian power systems, 300-kv power cable differential, and phase- and ground-overcurrent relays for the transmission system as well as a total ground current protection scheme.

Generator and high-voltage circuit breakers are air-blast type, the high-voltage breakers being rated at 6,000,000 kva symmetrical interrupting capacity. Impulse level of these circuit breakers is 1,050 kv for a 1.5x40-microsecond impulse, the same as for the main transformers and the 300-kv power cables.

Transmission-line design was influenced by the narrow valleys through which the route passes and the fact that about 10.6 miles run through a rather narrow pass with a maximum elevation of 5,300 feet. Expected very heavy ice and wind loads in this stretch, with a considerable depth of snow, led to the decision to build only two single-circuit tower lines in this section, where the world's largest aluminum cable, steel reinforced, with 3,364,000-circular-mil cross section, an outside diameter of 2.295 inches, a weight of 4.77 pounds per foot, and an ultimate strength of 135,700 pounds is being used.

For the remainder of the transmission lines, two double-circuit tower lines will be used, providing four circuits of 1,590,000-circular-mil aluminum cable, steel reinforced, 1.545-inch outside diameter, 2.032 pounds per foot, and 55,400 pounds ultimate strength. Double ground wires are being used at the line terminals for a distance of 1 mile only. The two sections of this design total about 39 miles in length.

At Kitimat terminal station, the incoming transmission lines will feed into a simple double-bus system, from which banks of single-phase forced-oil water-cooled-type transformers, each bank rated at 111,000 kva with one cooler in operation and 141,000 kva with two coolers, will be fed through air-blast circuit breakers. These 275/13.2-kv transformers, with four 2.5-per-cent taps, are solidly grounded through the high-tension neutral.

The individual potlines in the aluminum-reduction plant will be supplied by eight ignitron-type mercury-arc rectifier equipments, each rated at 12,500 kw. It is expected an efficiency of somewhat over 96 per cent will be secured, 13.2-kv a-c bus to 1,000 volt d-c bus.

The Nechako-Kemano-Kitimat hydroelectric power development, with an ultimate installed capacity of 2,240,000 horsepower, is the largest ever undertaken by private enterprise.

Digest of paper 53-321, "Electrical Aspects of Alcan's Kemano-Kitimat Hydroelectric Power Development," recommended by the AIEE Committee on Power Generation and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Pacific General Meeting, Vancouver, British Columbia, Canada, September 1–4, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

**F. L. Lawton** is with Aluminum Laboratories Ltd., Montreal, Quebec, Canada.

# Role of the Diesel-Electric Rail Car in Modern Service

K. O. ANDERSON
ASSOCIATE MEMBER AIEE

**The self-propelled rail car is returning to a place of popularity as the railroads seek to reduce costs and attract additional passenger business. Current rail-car applications in the United States cover relatively long main-line runs with diesel-hydraulic cars and branch-line service with light diesel-electric cars. Between these two extremes there exists a need for a main-line type of car capable of performing surburban service. Certain electric drive characteristics are well suited to this application.**

A GHOST HAS RETURNED to the nation's railroads. Considered dead for the past 20 years, the diesel-powered rail car has come back in numbers as railroads are reawakening to the advantage of providing adequate passenger service for their patrons. See Figure 1.

Not all roads, it is true, are trying to better their passenger service. Almost every week the Interstate Commerce Commission is petitioned to permit abandonment of another run. But there are some reversals to this trend. The New Haven, most notably, in the past year has added more than 50 new passenger trains to its schedules. It is planning even more, because it has found the passenger business lucrative. Rail cars are used on the lion's share of these new runs.

Other roads, too, are finding rail cars the answer to many of their passenger problems. Through their use, deficit operations have been turned into money-makers, or losses have been cut down considerably. Many of these roads are finding that rail cars make new services both possible and profitable. The New York Central, for instance, has restored passenger service to Midland, Mich., for the first time in 25 years.

**Figure 1. Diesel-hydraulic rail-car type in current use on a number of American railroads**

**Figure 2. Original Mack FCD diesel-electric rail car, built for the New York, New Haven and Hartford, here shown in service**

As the number of automobiles and trucks in operation continues to increase, this nation's highway system becomes ever more crowded. This problem, existing everywhere, but particularly critical in the more crowded areas, brings traffic to a literal crawl, and makes driving extremely hazardous, to say nothing of the human frustration involved.

Thus there is a natural tendency to turn to the rails for relief, wherever adequate service is offered. The word adequate here means clean comfortable equipment, operating on a fast schedule, and with reasonable frequency. Even crowded highways are preferable to a dirty, green-plush-upholstered coach of 1900 vintage creaking along behind a steamer at 20 miles per hour. Passengers simply will refuse to ride in such cars.

## PLACE OF THE RAIL CAR

LOCOMOTIVE-HAULED STREAMLINERS are suitable for long-distance runs, where enough demand exists to fill several cars. But on many of the shorter and interurban schedules, only one or two cars are required, which makes locomotive power and investment excessive and therefore uneconomical.

Diesel-powered rail cars appear to satisfy the need very well. The new ones being put into service today are clean and quiet, have high accelerating rates and high top speeds, and are economical to operate.

The well-known Budd *RDC*, of which 116 are in opera-

Full text of paper 53-361, "Wanted: A Modern Diesel-Electric Rail Car," recommended by the AIEE Committee on Land Transportation and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Middle Eastern District Meeting, Charleston, W. Va., September 29–October 1, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

**K. O. Anderson** is with the General Electric Company, Erie, Pa.

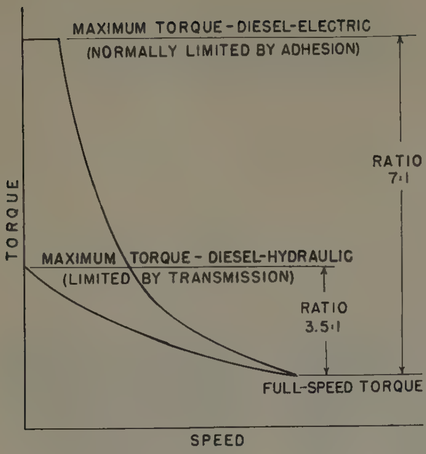



**Figure 3. Typical wrap-around characteristic for diesel-electric drive compared with that for diesel-hydraulic transmission**

tion or on order, is used on 13 railroads in the United States and in three foreign countries. Its two 275-gross-horsepower engines and 63 tons loaded weight give it an exceedingly high horsepower per ton ratio and consequently good acceleration characteristics. The hydraulic transmission—the first to be introduced for main-line rail service in the United States—has proved itself in service despite the skepticism of many "experts." Operating costs reasonably close to those predicted have been obtained.

Best of all is the flexibility that this new railroad tool has provided, as compared with locomotive-hauled trains. On the Pennsylvania-Reading Seashore lines, for instance, six cars in multiple unit with only one crew leave Camden, N. J. At Tuckahoe, two cars are cut off, and taken by another crew to Ocean City, while the other four proceed on the main line to Wildwood Junction. Again two are cut off for Cape May while the original crew proceeds with the remaining cars to Wildwood. On the return trip to Camden, a reverse procedure is followed.

Flexibility is the keynote of every rail car. Because it is a self-contained unit, it can be operated singly or in multiple as scheduling demands, and can be changed from one to the other with a minimum of effort.

Another, smaller, diesel-powered rail car with electric drive has been introduced on the New Haven. It is built by the Mack Manufacturing Corporation and named the Mack *FCD* Rail Car—after Frederick C. DuMaine, Sr., late president of the New Haven. The single-pilot model which now has been in operation more than a year is shown in Figure 2. After a lapse of 24 years, Fall River, Mass., now has passenger service provided by this "Little Shoreliner," as it is known on the New Haven.

The original car has a Mack 180-horsepower engine. The General Electric drive consists of a traction generator of the variety used on industrial diesel-electric locomotives and four Presidents' Conference Committee car type traction motors, together with suitable single-end single-unit control. It seats 45 passengers, has a top speed of 54 miles per hour, and is equipped with air-brakes. Essentially then, it is a Mack highway bus mounted on Presidents' Conference Committee trucks for rail operation.

The New Haven likes this car so well it has placed an order for nine additional units. These new cars will seat 50 passengers, and have 200-horsepower engines and top speed of 60 miles per hour. They will have double-end control and be equipped to operate two in multiple, thus giving additional flexibility.

## ELECTRIC DRIVE FOR MAIN-LINE CARS

These two different types of modern diesel-powered rail cars are not fundamentally competitive. They are far apart in total weight, horsepower, and seating capacity, as well as first cost. Their respective operating costs compare favorably to these factors. The Budd *RDC* is intended for main-line operation and has the necessary speed to stay out of the way of other traffic. The Mack rail car is an ideal unit for light branch-line service.

But a hiatus still exists in the needs of railroads for modern rail-car equipment of main-line size. A car is needed to do several things that any car equipped with a hydraulic transmission, in its present state of development, cannot do. These needs are

1. Good acceleration characteristics at low speeds.
2. Ability to pull trailers.
3. Ability to operate in electrified tunnels, such as at Grand Central Terminal, New York, N. Y.

Electric drive can satisfy this need.

The hydraulic transmission used on rail cars has its maximum torque at zero speed versus torque at maximum speed limited to about three to one ratio. This ratio is commonly called wrap-around. In contrast, an electric drive, even with a single motor connection, easily can provide six or seven to one wrap-around. See Figure 3.

Therefore, of two cars with the same horsepower per ton ratio, the one with electric drive can accelerate up to approximately 65 miles per hour more quickly than can the one with hydraulic transmission. This means that the former can cover a run of 5 to 6 miles or less more quickly than can the latter. Many commuter schedules call for stops only 1 or 2 miles apart. Obviously, a car with electric drive will do such jobs better. For runs of greater length, the hydraulic transmission car has the advantage, since it goes into "locked-up" direct drive, where the only loss is in the gearing. Here, it should be

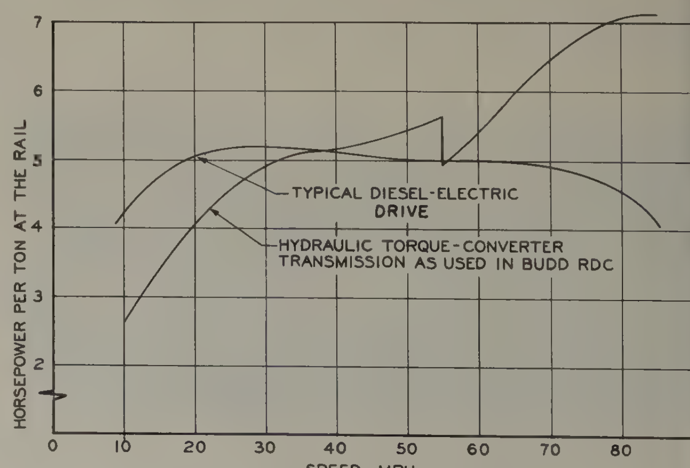



**Figure 4. Transmission characteristics for diesel-powered rail cars**

noted, it is the practice to run the engine at higher speeds than when the transmission is in use, thus actually producing more horsepower, since engine torque is essentially constant. These facts are shown in Figures 4 to 6.

## USE OF TRAILERS

In addition to the high rate of acceleration at low speeds, the rail car equipped with electric drive easily can pull trailers without harm. Thus much greater flexibility of operation without excessive added investment can be obtained. The diesel-hydraulic car, as now applied to United States railroads, is not designed for pulling trailers. While the diesel-electric rail car will have somewhat lower acceleration when pulling a trailer than when running by itself, it will not deteriorate in performance so much as to be unusable. The balancing speed on level tangent track of a motor-car–trailer-car combination (of equal weights) will be only about 10 per cent less than that of a motor car alone.

Ordinary passenger coaches could be used as trailers with this rail car so long as they were self-contained units. That is, they need not be dependent upon the power car for either train heat or electric power. Since the required heating load of a passenger car in zero-degree-Fahrenheit weather is approximately equal to the air-conditioning load in summer, the diesel-electric under-car power plant would provide both these services, thus making the car truly independent. As an added benefit, this car would not then have the axle generator type of power supply which provides added drag on the train's prime mover.

## OPERATING AND MAINTENANCE ADVANTAGES

Railroads already are finding difficulty in operating diesel-powered rail cars when they must enter electrified tunnel zones, where the engines cannot be run underground. In the case of the diesel-hydraulic car, the only recourse is to pull the car with an electric locomotive, but in the case of the diesel-electric car, it would be a comparatively simple matter to provide a pickup and additional control to operate it from third-rail power.

At the present time, the hydraulic transmission is still a mystery to most railroad shops. Consequently, this

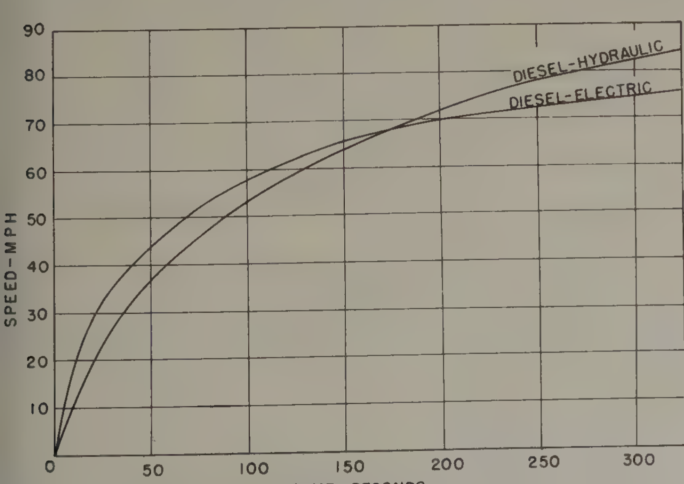
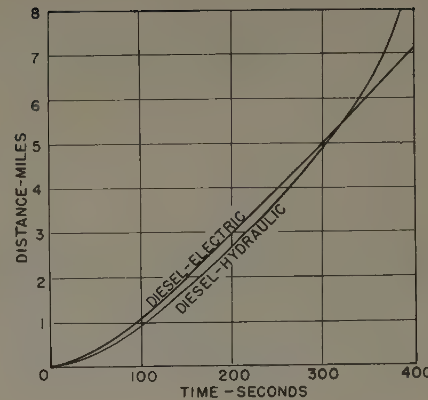



**Figure 5. Speed–time characteristics for a diesel-electric and a diesel-hydraulic rail car (equal horsepower per ton ratios)**

**Figure 6. Distance–time characteristics for a diesel-electric and a diesel-hydraulic rail car (equal horsepower per ton ratios)**




transmission often is returned to the manufacturer when it needs repair. On the other hand, with but one exception, all the Class I railroads in the United States now have diesel-electric locomotives and easily could service a diesel-electric rail car. It even is conceivable that many components now in use on the locomotives could be used on the rail cars thereby easing the renewal parts problem.

In all railroad equipment, reliability and low maintenance costs are the key to success. For a new design of diesel-electric rail car then, reliability must be built into it. Most of all, as the heart of the car, the engine or engines must be thoroughly reliable. Many railroad men are inclined to look at a high-speed (1,800 to 2,100 rpm) engine with disfavor because they doubt its reliability. Some of them feel that an engine operating at 1,000 rpm or less is inherently more reliable. Unfortunately, several high-speed engines have been applied improperly in railroad service and thus the reputation of this whole series of engines has suffered. On the other hand, high-speed engines have performed well on industrial locomotives and in thousands of automotive applications. Fundamentally, a high-speed engine properly applied can be just as reliable as a low-speed engine. And the lower weight, smaller space, and probable lower cost of a high-speed engine should be considered in over-all car design.

The problem of maintenance should not be overlooked in a car's design. This will mean that the entire engine or perhaps the complete power unit must be able to be removed easily from the car so that it can be taken to a convenient place for work. Few railroad shops have the necessary floor space to accommodate an 85-foot car while work is being done on the engine, but every railroad operating a fleet of these cars can afford to have a few extra engines as replacement units while the car's original equipment is being repaired. As another advantage, an entire car need not be held out of service while the engine is repaired, thus the over-all investment would be lower.

## CONCLUSION

Through proper design, attractive accommodations, and judicious scheduling of runs when and where the passengers want them, rail cars can help the railroads win passenger traffic back to the rails. This thesis has been proved by the preliminary steps taken to date. Now is the time to design a diesel-electric rail-car for main-line service that will speed this move.

# Automatic Testing of Wired Relay Circuits

A. N. HANSON
MEMBER AIEE

PRACTICALLY ALL of the telephone switching equipment in an automatic exchange is made up of wired assemblies of relays and other components interconnected by a multiplicity of wires. Many of these assemblies are made up of smaller components called "relay circuit units." These vary in size, and after testing, are mounted in larger frameworks. A careful check of connections and electrical continuity is essential to assure that these units will function properly when connected to other circuits in a telephone exchange.

Buzzer continuity tests lack much in effectiveness. Manually operated test sets are more flexible than automatic test sets but require setup time and are subject to operator error. The particular automatic set, which is the subject of this article, was designed to give complete flexibility and eliminate the undesirable features of a manual test set. Figure 1 shows the test set known as the Universal Equipment Test Set. The cabinet to the upper right houses display lamps, resistors, control switches, and so on, for testing purposes. Directly below this cabinet is mounted the tape reader. The larger cabinet under the table top houses the switching relays, resistors, capacitors, and so forth, required for testing. On the table top is a typical unit connected for testing. Figure 2 shows in block diagram the main components of the Universal Equipment Test Set.

The tape is of specially prepared paper 3 inches wide, perforated with embossments in a pattern that can be read by reading pins of an automatic message accounting reader. There are 28 embossment positions across one line, divided into six groups, *A* to *F*. Group *A* has three positions for perforations and groups *B* to *F* have five positions each.

The tape reader steps the tape at a rate of 16 steps per second. Between each step, 28 sensing pins descend to the tape. When an embossment permits a pin to pass through the tape, a pair of contacts close providing ground potential to complete a circuit path to operate reader relays. The reader relays are wired to control other relays of the test-set switching circuit in the various phases of testing. If no hole is found, the contacts remain open when the pins strike the paper.

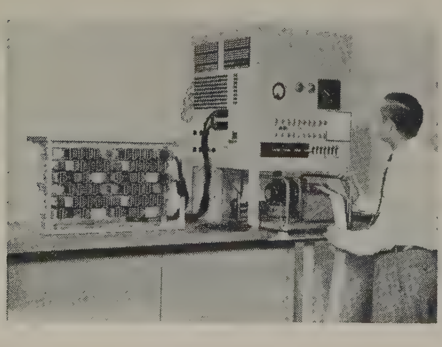


Figure 1. The Universal Equipment Test Set with unit under test

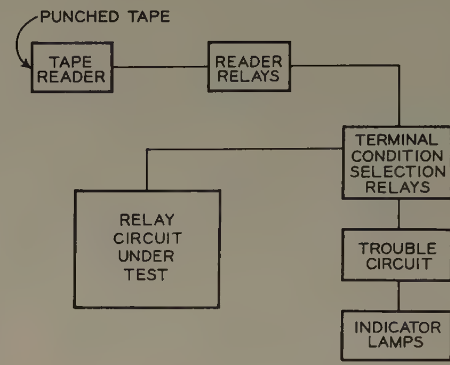



Figure 2. Test Set functional block diagram

Test set terminals are connected to the circuit under test through fixtures that contact the circuit connecting block terminations. To each of these terminations is connected a set of four relays that, when operated in various combinations, will provide the particular test condition desired for that terminal. The perforations in tape groups *A*, *B*, and *C* select the particular terminal desired while the perforations in tape group *D* determine the testing condition to be applied to the unit under test by operating the proper combinations of the four aforementioned relays. The circuit condition set up by the *D* group of perforations is electrically locked in that combination until the results of that test are verified.

At desired intervals, a line of perforations is set up on the tape to verify conditions received from the circuit under test, that will indicate the correctness of the wiring of the unit. This line of perforations is inserted rather frequently to reduce the field to be searched when trouble is encountered. At this time a circuit is introduced that will stop immediately the progress of the test if trouble is encountered. Indicator lamps on the test set identify the connecting block terminal that terminates the defective circuit in the unit under test. The test circuit checks not only that portion of the circuit from which potentials are expected back from the unit under test, but checks every terminal of the unit to insure that those terminals which should be free of all potential do not carry battery or ground due to a short circuit. Should the information received by the test set be satisfactory, the test progresses automatically.

Tapes perforated to check all of the operating features of the test set are used for maintenance purposes. These tapes not only exercise the test set but actually introduce trouble conditions to insure that the test set will detect them.

Digest of paper 53-407, "Automatic Testing of Wired Relay Circuits," recommended by the AIEE Committee on Communication Switching Systems and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Kansas City, Mo., November 2–6, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

A. N. Hanson is with the Western Electric Company, Inc., Chicago, Ill.

# Transistors in 4A Toll Crossbar Switching

P. MALLERY

THE LATEST ADVANCE in the automatic handling of toll telephone calls is the *4A* Toll Crossbar Switching System. The heart of this system is the card translator. In it is stored the necessary information to route a call to any one of the toll or local offices in the United States and Canada. Its operation is based on selecting a pattern of light beams corresponding to the routing information required. Determination of the routing information is made by detecting which light beams, called channels, are present during each translation.

To detect which channels are illuminated, the card translator depends upon phototransistors. A phototransistor of the type used requires only about 12 millilumens of light for satisfactory operation. In the card translator the light is supplied for its 118 channels by a single 500-watt projection-type lamp operating on half voltage to insure long life. The light from this lamp is interrupted at a 400-cycle rate by a motor-driven perforated disk. Interrupted light is used as it is easier to build a-c than d-c amplifiers and also by this means the ratio between the light and dark currents of the phototransistor is important rather than the absolute value of either.

When making a translation, the light of an illuminated channel falls upon the phototransistor of that particular channel. This is shown schematically in the circuit diagram of Figure 1. The light acts as the emitter of the phototransistor. The collector is of the conventional type for point-contact transistors. As is normal in grounded-base transistor circuits, the collector is biased in the high-impedance direction. The type of phototransistor used has a collector impedance of about 10,000 ohms when dark which is reduced to approximately 3,000 ohms when illuminated.

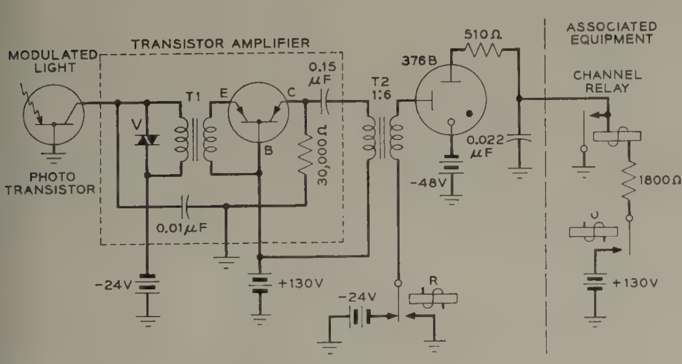



**Figure 1. Electrical section of channel circuit**

The a-c signal from the phototransistor is applied to the transistor amplifier. Transformer *T1* permits convenient matching of impedances and separation of bias voltages. The amplifier is a conventional common-base arrangement with a voltage gain ranging from 40 to 100. To guarantee operation a minimum positive-peak output voltage of 38.5 has been set as the rejection point for a phototransistor-amplifier combination.

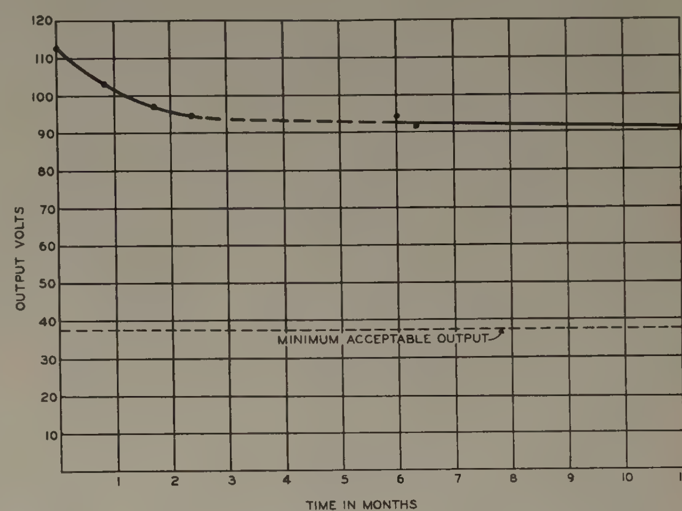



**Figure 2. Average output voltage of 96 phototransistor-amplifier combinations**

The output of the transistor amplifier is used to trigger a cold-cathode gas tube. When a translation is to be made, relay *R* is operated by an auxiliary checking circuit to change the bias and thereby increase operating margin. The associated equipment closes positive 130 volts through its channel relays and the gas tubes of the illuminated channels transfer to their main gaps, operating their associated channel relays.

To test this circuit for reliable operation, three card translators equipped with 272 channel circuits were installed in the laboratory. In all, 28,000,000 translations were made with negligible failures. Each translation required many channel operations. At the same time, output voltage measurements were made as a life study. Figure 2 shows the average output voltage of 96 phototransistor-amplifier combinations as they change with time. This curve is based on data taken from two groups of transistor elements.

The test results show that the transistor and the circuits as used in the card translator are reliable. In addition their service life appears to be satisfactory.

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Digest of paper 53-218, "Transistors and Their Circuits in the *4A* Toll Crossbar Switching System," recommended by the AIEE Committee on Communications Switching Systems and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer General Meeting, Atlantic City, N. J., June 15–19, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

P. Mallery is with Bell Telephone Laboratories, Inc., New York, N. Y.

# Tie-Line Power and Frequency Control

CHARLES CONCORDIA
FELLOW AIEE

L. K. KIRCHMAYER
ASSOCIATE MEMBER AIEE

THIS ARTICLE extends a previous study[1] to include hydroelectric power generating areas. As before, the object is to determine theoretically the best values of controller gains; that is, to find those controller settings that will result in best over-all system performance.

Hydroelectric power systems differ from steam-electric power systems in that the relatively large inertia of the water used as the source of energy causes a considerably greater time lag in the response of changes of the prime-mover torque to changes in gate position, and also an initial tendency for the torque to change in a direction opposite to that finally produced. In addition, the response may contain oscillating components caused by the compressibility of the water (and expansion of the piping) or by surge tanks. These response characteristics, in conjunction with the limitations on permissible surge pressures, make it necessary to use speed governors having very different characteristics in order to secure stable operation. Usually, the speed governor has a relatively large temporary droop and long washout time. The over-all result is usually a system with longer time lags and a smaller margin of stability. Correspondingly, it is found that the optimum frequency and tie-line power controller gains—which express the rate of correction for a given (small) error signal—are much smaller than for a steam-electric power system.

In addition to the parameters of rotary inertia, self-regulation (or load damping), governor speed droop, and tie-line strength, which characterized the steam-electric system, the hydroelectric system involves also the temporary (or transient) droop and washout time constant of the speed governor and the inertia and equivalent compressibility of the water. (The steam turbine also has a lag attributable to the steam, but this is so small that it has only a minor effect on load and frequency control.) This doubling of the number of significant parameters makes it more difficult to arrive at simple but general rules to express the optimum control characteristics.

The behavior of the system as affected by various system parameters was studied by determining the response to step load disturbances of 1 per cent applied to each generating area in turn. Responses were obtained by the aid of both a mechanical and an electronic differential analyzer.

The optimum settings for the speed-governor transient droop and washout time constant were found with and without supplementary control, and then the supplementary control gains were selected to give the best response of both frequency and tie-line power, considering stability, rapidity, and possible overshoot.

The results obtained in this study have led to the following conclusions:

1. In the case of hydroelectric power systems, just as for steam-electric power systems, the turbine speed governors usually can be adjusted for optimum performance without consideration of the supplementary tie-line power and frequency control.
2. For interconnected systems the optimum washout, or droop-reset, time constant $T_R$ will be considerably greater than for hydroelectric machines supplying single-power systems; the optimum value may be about twice the hydraulic (water inertia) starting time. The effect of $T_R$ is principally on the frequency swings and not on the tie-line-power swings.
3. The optimum gains of tie-line power and frequency control signals for hydroelectric power systems of the type considered here are considerably smaller than for steam-electric power systems (about 1/12 for tie-line power signal gain and 1/16 for frequency signal gain).
4. Confirming the results found in the previous study of steam-electric power systems, the optimum tie-line power and frequency signal gains are practically independent of each other, and are also almost completely independent of the various characteristics of connected power generating areas.
5. The response of the entire interconnected power system to a given load change depends very much upon the parameters of the controllers in the area in which the load change occurs, although there is some averaging effect when the controllers are very different.
6. Participation of all machines in the regulation and minimizing of governor deadbands are major contributing factors to good control of system frequency and tie-line power.
7. For hydroelectric power areas, when both the frequency and load control gains are optimum, the ratio $K_t/K_f$ is very nearly equal to the effective transient speed regulation, taking the system self-regulation into account. However, varying the tie-line power signal gain does not affect the frequency deviation appreciably, and conversely, varying the frequency signal gain does not affect the tie-line power deviation appreciably.
8. The periodic surging due to water compressibility has a negligible effect on the frequency swings, but causes the tie-line power swings to be better damped. Slow periodic oscillations may be introduced into the frequency and tie-line power by a surge tank.

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**Charles Concordia** and **L. K. Kirchmayer** are with the General Electric Company, Schenectady, N. Y.

# Economic Aspects of Electric Oil-Well Beam Pumping

T. L. SCOTT

**Emphasis is placed upon making a careful accurate evaluation of all the cost factors involved in investment cost, operating cost, and lost-production cost due to down time to determine the most economical and efficient type of prime mover to operate beam pumping wells.**

BEAM PUMPING is by far the oldest and most common method of artificially producing oil wells, and essentially consists of a subsurface pump attached to a string of steel sucker rods connected to a beam which, in turn, is given a controlled reciprocating motion through a crank and a system of gears driven by a prime mover.

The accepted use of beam pumping is based on the success of its past performance. The use of electric motors to operate beam pumping units is by comparison, relatively new, but the increasing trend toward operating beam pumping units electrically also is based on its successful usage. To illustrate this the results of electrification on a few properties are reviewed:

*Property Number 1.* Sixty wells with engines operating on sour gas were electrified in 1947. The original study justifying the replacement of gas engines with electric motors estimated the savings to be $15,000 per year. The actual increased profit for 1948 was $57,000, and the investment cost was paid out in 15 months.

*Property Number 2.* Sixteen wells operating with gas engines were electrified in 1950. The predicted annual saving was $6,400, but the actual increased profit was $8,200, and the investment cost was paid out in 26 months.

*Property Number 3.* Another study concluded that the cost of electrifying 43 wells would pay out in 10 years and that electric motor operation could not be justified. However, a second and more recent study showed that the electrification of the 43 wells would result in a minimum annual saving of $21,000 and an investment payout of 18 months.

However, to conclude that the electrification of all wells would be equally profitable would be erroneous, as clearly shown by the following example:

*Property Number 4.* From a study of 24 wells to be artificially lifted, it was concluded that the use of electric motors would result in an increased profit of $25,000 per year. A second, more comprehensive study showed that the operation of the 24 wells with gas engines would result in an increased profit of $20,000 per year.

In the preceding examples, the differences in the predicted and actual increased profits show a need for a sound basis for evaluating the relative economics of electric motor and gas engine operations.

The question then may be asked, "What economic considerations are involved in the selection of electric motors or gas engines to operate oil well pumping units?" To answer the question, the cost of many factors must be determined. These factors may be summarized under three general headings:

1. Investment cost.
2. Operating cost.
3. Cost of lost production due to down time.

Some of these factors can be identified very easily. However, many of the factors are difficult to evaluate because: The more accessible company cost records are prepared as general summaries; the more detailed cost records are filed in many places and are not always readily available; certain factors are not covered by specific cost records.

The factors most favorable to electrifying one project will not always apply to another, and it will be necessary to make an analysis on a per well or area basis for each separate project. For the same reason, all cost factors should be evaluated, and where they are not covered by specific company records, reasonable estimates should be made on the basis of available information, method analysis, and experience.

**Figure 1. Beam pumping installation at Odessa, Tex., which pumps from 4,600 feet utilizing a 15-horsepower electric motor**

Essentially full text of a conference paper presented at the AIEE Fall General Meeting, Kansas City, Mo., November 2–6, 1953, and recommended for publication by the AIEE Petroleum Industry Subcommittee.

T. L. Scott is with Phillips Petroleum Company, Bartlesville, Okla.

The author wishes to express appreciation for assistance received from M. H. Halderson, E. S. Miles, and Roger Filson

**Figure 2 (left). Another beam-pumping installation at Smackover, Ark., which uses a 25-horsepower electric motor to pump from 2,300 feet**

General statements have been made that: (1) electric motors must be restricted to loads of less than 15 horsepower; or (2) gas engines should be used where the electric energy cost is greater than $1^1/_2$ cents per kilowatt-hour. These statements are misleading, for it has been found profitable to electrify some wells where the motors are as large as 60 horsepower and to pay energy charges of more than 3 cents per kilowatt-hour where the power requirements were small.

It is obvious that it would be impractical to discuss all of the cost factors in detail, so only a brief discussion of some of the cost factors for selecting the most economical type of prime mover can be presented here.

## INVESTMENT COST

*New Installations.* In the selection of a prime mover, it is imperative to consider first the investment cost, and it generally will be found that the investment cost will be less with electrification than gas engines. This difference in initial costs generally will vary from $100 to $700 per well, on installations of 3 to 20 horsepower, but there are isolated instances where the difference may be greater.

A recent comparison of costs for two proposed installations, with prime mover loads of 12 and 43 horsepower, showed the differences in respective investment costs to be $500 and $1,600 in favor of electrification.

*Replacement.* There are many pumping wells equipped with gas engines that could be operated more economically with electric motors, but to justify the replacement of these gas engines, the reduction in operating expense must be great enough to allow a favorable payout of the investment cost. In some cases, this cannot be done. For instance, assuming that the replacement of a gas engine with an electric motor would require an investment of only $720 and result in a saving of $20 per month. If corporation taxes are disregarded, the investment payout would be 3 years, but because of taxes, this payout would be extended to approximately 6 years which would not be considered an attractive payout by most oil companies. The preceding should serve as an example of the importance of correctly evaluating all cost factors before a new beam pumping installation is made.

The operating life of an electric motor is considerably longer than that of a gas engine, and our experience indicates that the replacement of electric motors for reasons of mechanical failure or obsolescence should be disregarded as a cost factor.

*Availability of Electric Power or Fuel Gas.* Electric power or fuel gas facilities generally will be found in or near a large percentage of all the oil fields, and most utility companies either will build power lines to the producing property or to the well. Where electric power or fuel gas facilities are not available in the vicinity of the property, the cost of constructing long power or gas lines becomes an important factor in determining the type of prime mover.

Availability of future fuel gas reserves is important. If a field produces insufficient gas in the later stages of its producing life and other gas facilities are not available or too costly, conversion from gas engines to electric motors becomes necessary if the well production is great enough to justify the replacement.

## OPERATING COST

*Horsepower Requirements.* The power requirement of a pumping well largely determines the investment cost and directly affects the operating cost of a prime mover. Horsepower load is a very significant factor in the selection of the most economical prime mover for a pumping well, and for this reason, it must be measured or calculated with reasonable accuracy.

Where it is a question of prime mover replacement, the present prime mover horsepower can be obtained easily by measurement. However, the predicted power requirements for an initial or future maximum pumping load must be based on a study or available knowledge of the reservoir and experience with producing wells in similar pools.

*Cost of Electric Energy.* The relative importance of the electric power rate is dependent upon prime mover load. For example, with small loads of 1 horsepower or less, the power rate is of secondary importance. However, the power rate would be a major consideration with a prime mover load of 50 horsepower.

Our electric energy charges range from 7.8 mils to more than 3 cents per kilowatt-hour. We have one well where the power rate is more than 3 cents per kilowatt-hour, and the monthly power bill is less than $5 per month. There are many other wells where the power requirements are small and the monthly power cost is less than $10.

The electric energy cost is the largest single expense item with electric operation and generally will be between 90 and 98.5 per cent of the total electric motor operating cost. The electric rate is one of the major considerations, but it is not always a determining factor.

*Cost of Fuel Gas.* The cost and availability of fuel gas should be investigated from a present and future standpoint. Present trends indicate that gas costs are increasing at a faster rate than electric energy costs. Our gas costs vary from "free gas" to over 35 cents per 1,000 cubic feet.

Our engine gas consumption varies from 12 to 25 cubic feet per horsepower-hour, and the average engine gas consumption is 18 cubic feet per horsepower-hour. With gas at 35 cents per 1,000 cubic feet and the fuel gas consumption at 18 cubic feet per horsepower-hour, the cost of gas is approximately equivalent to paying an electric rate of 7 mils per kilowatt-hour at the meter.

The cost of gas-line maintenance and gas leakage should be included in the cost of the fuel gas. Important items in deriving this cost are: extent of gas system, condition of gas line, corrosive properties of soil and sour gas, and type of pipe joints.

*Pumper Labor.* The old practice of determining labor requirements by opinion instead of actual analysis resulted in very costly, inefficient use of labor. The very rapid increases in direct and indirect labor costs necessitate better methods of evaluating the labor requirements.

Method analysts now are being used extensively to measure the actual work requirements. From these measurements, it has been found that a pumper can operate from 2 to 3 times more beam pumping wells with electric motors than those equipped with gas engines.

In some cases, it will be found that the extent to which the potential labor saving due to electrification can be utilized will depend upon the number of wells and the size of the properties, but as a rule, a large percentage of the saving can be made.

The calculation of the cost or saving of labor should include both direct and indirect costs. The actual cost of a pumping job to most oil companies is from 1.8 to 2.3 times the base rate of pay for one man when the cost of items such as supervision, housing, relief, transportation, vacation, retirement plan, thrift plan, unemployment compensation, and social security are included.

It should be emphasized that the electric motor is a labor-saving device, and if we are to utilize the full economic benefits of electrification, we must measure the actual work requirements and utilize the large potential labor savings.

*Repair Labor and Material.* As previously stated, the cost of repair labor and material is not an important cost item with electric motor operation. However, this cost is a significant part of the gas engine operating costs, and it will vary considerably from engine to engine.

When evaluating the cost for gas engines, consideration must be given to such items as: 1. whether sweet or sour fuel gas is being used; 2. whether or not there is a regularly scheduled preventive maintenance program; 3. quality of the maintenance work; 4. cost of supervising maintenance work; 5. transportation cost; 6. material costs; 7. material handling cost; 8. base rate of pay for repair labor; and 9. base rate multiplier for actual labor cost to company.

The cost of engine repair labor and material is difficult to evaluate, but it must be known within a reasonable degree of accuracy before a decision can be made as to which type of prime mover is the more economical.

*Speed Control.* Good pumping speed control is an essential part of the operation of getting the desired production with the least pump wear and sucker rod breakage. It is particularly important where wells are heavy producers or deep, because of the small differential between the desired speed and the critical speed where excessive sucker rod breakage occurs.

Speed control is not an operating problem with electric motors, but with gas engines, it requires constant vigilance and supervision for economical operation. However, efforts to maintain the optimum speed with gas engines have not been successful always. For instance, the replacement of a gas engine with an electric motor on one deep well resulted in an estimated reduction of $100 per month in replacement and well servicing for sucker rod breakage, and the electrification of a large group of wells resulted in a 23-per-cent reduction in well servicing costs.

Though the benefits of speed control are difficult to evaluate, it can be an important consideration in the selection of a prime mover and should be determined or estimated in all cases.

## LOST PRODUCTION DUE TO DOWN TIME

The effect of down time on lost production varies greatly. If the wells are prorated and easily can make the allowable, down time may not be of consequence. Some wells partially will make up lost production while others will not.

Lost production due to down time often is considered as deferred production, but the value of this oil is considered to be lost for the following reasons: 1. in many of the pools we are competing for the oil, and if we do not recover it, our competitors will; 2. lifting costs to produce deferred oil will be higher; 3. there would be an extension of fixed operating costs; 4. if the lost production is considered as deferred production, it may not be profitable to produce it later in the life of the field; 5. present worth of oil deferred for 10 or 15 years is one-fourth to one-third of current value.

Down time is one of the most significant factors favoring oil-field electrification. Where gas engines have been replaced with electric motors, production increases of from 1 to 9 per cent have been obtained.

## SUMMARY

To summarize briefly, the selection of the most economical and efficient type of prime mover to operate the beam pumping wells does not depend upon the use of general rules, but rather, upon a careful, accurate evaluation of all the cost factors which are covered by investment cost, operating cost, and the cost of lost production due to down time.

# Program Transmission Over Type N Carrier Telephone

R. L. CASE
MEMBER AIEE

IDEN KERNEY

WITH THE ADVENT of the type *N* carrier telephone system[1] about 3 years ago providing high-speed temperature-stable economical telephone circuits over the shorter cable network, it became very desirable to adapt the type *N* system to the transmission of both Schedule *A* and *C* programs. The flexibility of the proposed arrangements, the economics envisioned, and the increasing difficulties of meeting requirements such as high speed of propagation for the sound channel of television circuits with voice-frequency loaded cable were all factors contributing to the decision to provide program transmission over type *N* carrier.

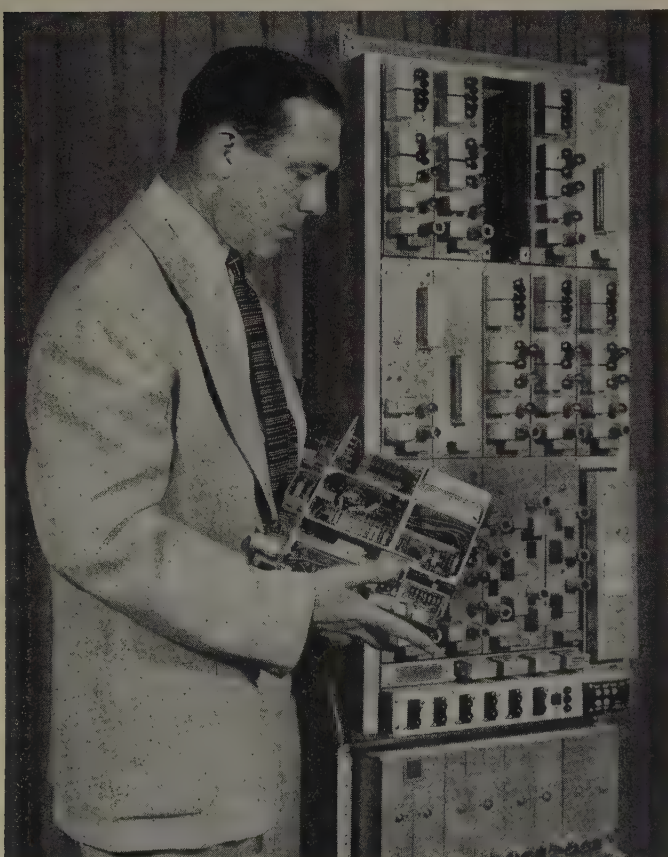

Figure 1. Type N terminal equipped with Schedule A channel unit and plates and engineer inspecting Schedule C unit

Schedule *A* program requires a band width of approximately 100 to 5,000 cycles which is wider than the total space allotted to a type *N* channel. To obtain this band it is necessary to give up three message channels. Schedule *C* program occupies the band between 200 and 3,500 cycles and while it requires the space of a single channel it is necessary to widen the message band.

Like the type *N* message channel units the Schedule *C* program channel unit consists of compressor, expandor, and carrier subassemblies. The compressor and expandor subassemblies are the same for all 12 channel units but have been modified for program use by substituting higher cutoff transmitting and receiving low-pass filters and by changing the equalizer to extend the band down to 200 cycles and up to 3,500 cycles. The 3,700-cycle built-in signaling equipment was removed from the message expandor subassembly and additional filtering was provided in the plate circuit of both subassemblies to permit simultaneous programs in both directions with negligible crosstalk between the two programs.

For Schedule *A* program, message channel units 5, 6 and 7 are removed and replaced by a program unit having a carrier subassembly similar to channel 6 but with a 5-kc wide-band receiving filter. The message compressor and expandor subassemblies are replaced by a single unit consisting of an equalizer and transformers to couple the 600-ohm sending and receiving circuits to the carrier modulator and demodulator. External equalizers, predistorting and restoring networks, and compandor with a wider frequency band are employed. To avoid the necessity for heater voltage readjustment, plates each equipped with a resistance load are provided to fill the blank spaces left by removing message channels 5 and 7.

The type *N* bay equipped with a Schedule *A* program unit and two plates is shown in Figure 1. An engineer inspecting a Schedule *C* unit also is shown in the illustration. Typical transmission frequency characteristics for a Schedule *A* and a Schedule *C* system are shown in Figure 2.

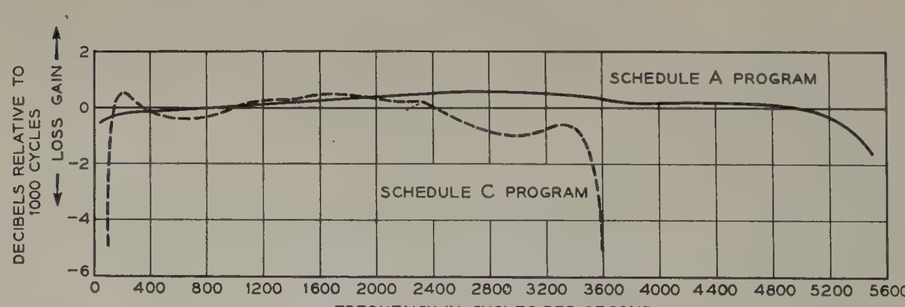


Figure 2. Typical transmission frequency characteristics of single-link type N Schedule C and Schedule A program circuits

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Digest of paper 53-335, "Program Transmission Over Type *N* Carrier Telephone," recommended by the AIEE Committee on Wire Communications Systems and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Pacific General Meeting, Vancouver, British Columbia, Canada, September 1–4, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

R. L. Case and Iden Kerney are with Bell Telephone Laboratories, Inc., New York, N. Y.

# The Detroit Committee on Electrolysis

R. L. RAYNER
MEMBER AIEE

THE DETROIT Committee on Electrolysis is a voluntary organization of companies and municipal departments constituted for finding the best engineering solution to the electrolysis and corrosion problems confronting its members. It is typical of active electrolysis committees in more than 25 cities and areas in the United States and Canada. The Detroit Committee on Electrolysis was organized in 1922 and it has functioned without interruption from that date to the present time.

The outstanding objective of this committee is to promote co-operative effort which is essential in electrolysis and corrosion problems. Independent effort is likely to result in the application of measures which would protect the property of one company and at the same time create a hazard to the property of another.

Membership on the Detroit Committee on Electrolysis may be maintained by any company or municipal department which has property in Detroit, Mich., or adjacent communities and is involved in creating conditions which may cause electrolysis or possesses property which may be damaged thereby. At the present time there are 30 member organizations. Representation for the purpose of voting is arranged so that each member organization has one vote.

The Detroit Committee on Electrolysis is divided into three departments: the General Committee, the Executive Committee, and the Technical Committee.

The General Committee is composed of one official representative and one alternate from each member organization. Additional representatives without voting power also may attend committee meetings. The representatives to the General Committee are usually officials, executives, engineers, or supervisors of the companies which they represent. Since these people hold positions of influence on questions concerning electrolysis and corrosion in their respective companies, they expedite the approval of recommendations made by the committee and they also expedite the approval of necessary testing work and remedial measures.

The General Committee holds three or more noon luncheon meetings per year. At these meetings they review the work of the Technical Committee which often requires making recommendations and decisions on controversial subjects. It has been the practice for several years to supplement the business session with papers presented by outstanding speakers.

In addition to its routine work, the General Committee has entered into several additional activities. One of the most important of these consists of keeping records of drains, bonds, anodes, and rectifiers which are used by its members in the prevention of electrolysis damage.

The officers of the General Committee are a chairman and a vice-chairman who are elected and a secretary-treasurer who is appointed by the chairman. The expenses of the committee, which are largely associated with the work of the secretary-treasurer, are absorbed by the company which he represents. For this reason, it has been the practice to rotate the appointment of the secretary-treasurer among the major companies represented by the committee.

In addition to the General Committee, there are the two afore-mentioned standing committees, the Executive Committee and the Technical Committee.

The Executive Committee consists of the officers of the General Committee, the chairman of the Technical Committee, plus two members selected at large from the General Committee. The Executive Committee members plan and control the general order of business of the Detroit Committee on Electrolysis. They also make decisions from time to time on controversial questions which could not be handled conveniently in a large group.

The Technical Committee is composed of representatives of member organizations which have active electrolysis problems. They usually are field people engaged in the detection, measurement, and mitigation of electrolysis problems and it is not necessary that they be members of the General Committee.

The Technical Committee reviews reports of unsatisfactory electrolysis conditions, devises test methods, calls upon member organizations for the assistance of men and the use of testing equipment to carry out joint testing sessions, analyzes the data obtained from the tests, recommends remedial measures, and reports to the General Committee on technical details regarding the cases handled.

The Detroit Committee on Electrolysis has handled electrolysis and corrosion problems in Detroit and in surrounding communities to the mutual satisfaction of all of its members for well over a quarter of a century. Through its General Committee, it has held the interest of executives and supervisory people and it has used them to control policies and expedite approval of recommended measures. Through its Technical Committee, it has handled detailed problems and arranged for joint testing programs. These were followed by the application of remedial measures which have resulted in enormous savings.

When the committee was organized, practically all problems related to stray current from street railway systems. In recent years, many street railway lines have been discontinued, but with the addition of pipe lines with cathodic protection and with the extension of other underground structures electrolysis and corrosion problems have increased both in number and complexity. Therefore, the work of the Detroit Committee on Electrolysis is fully as important now as at any time in its history.

Digest of paper 53-413, "A Discussion of the Detroit Committee on Electrolysis," recommended by the AIEE Committee on Chemical, Electrochemical, and Electrothermal Applications and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Kansas City, Mo., November 2–6, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

**R. L. Rayner** is with Michigan Bell Telephone Company, Detroit, Mich.

# Map Method for Synthesis of Logic Circuits

M. KARNAUGH

THE MAP METHOD is a scheme for simplifying the derivation of logical forms for digital control and computing circuits. It comprises a number of improvements and extensions of a procedure suggested by E. W. Veitch,[1] who pointed out that each logical function may be represented uniquely by a rectangular array, the pattern of which leads to the synthesis of a simple, Boolean algebraic representation.

A 4-variable function is mapped in Figure 1. The 16 small squares represent the $2^4$ possible combinations of values (called input conditions) of the 2-valued (0, 1) variables $A$, $B$, $C$, $D$. The rows or columns within any bracket are those in which the designated variable has the value 1, while it is 0 elsewhere.

The mapped function has the value 0 in the empty squares, the value 1 in the squares so marked (called *p*-squares because they are represented by algebraic products), and is unspecified in the *d*-squares. In the latter cases, the designer may assign values to the function which make possible a simple representation.

A subcube is defined as the complete set of squares within which some of the variables have fixed values. A subcube consisting entirely of *p*-squares will be called a *p*-subcube.

The algebraic representation of a *p*-subcube is a product of all the variables which are constant within it. Each factor is primed (that is, negated) if and only if its value within the *p*-subcube is 0. It is easy to see that such a product equals 1 within the *p*-subcube and equals 0 elsewhere.

Any function may be put in a simplified "and-or" form as follows:

(*a*). Choose a set of *p*-subcubes which includes every *p*-square at least once. In general, the selected *p*-subcubes should be as large and as few in number as possible.

(*b*). Write down the sum of the products which represent the selected *p*-subcubes. This is the desired function.

The function in Figure 1 is represented most simply in

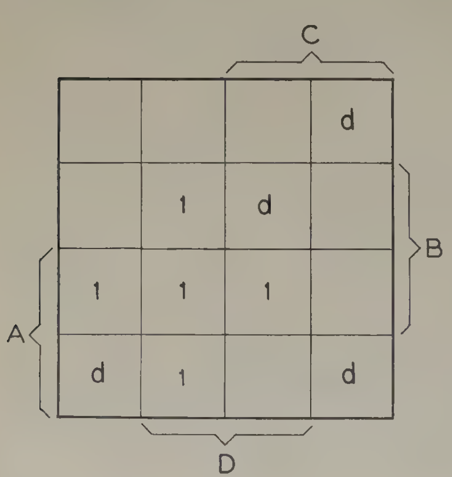


**Figure 1. Map of an incompletely specified function**

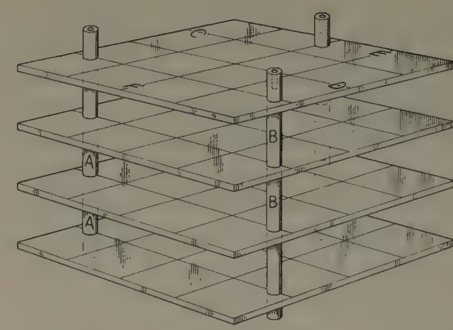


**Figure 2. The cube: a 3-dimensional plastic framework for maps**

"and-or" form by setting the two *d*'s on the right equal to 0, and the other two *d*'s equal to 1. Then only two *p*-subcubes are required, giving $f=AC'+BD$.

For more than four variables, 3-dimensional arrays are proposed. A plexiglass framework for 6-variable problems is shown in Figure 2. It is a cube, 6 inches on each side. In using it, writing and erasing are eliminated by the employment of movable markers, such as 7/8-inch plastic roulette chips. The following scheme is suggested:

(*a*). Mark *p*-squares with white chips.

(*b*). Mark *d*-squares with black chips.

(*c*). As *p*-subcubes are selected, mark each one with a set of distinctively colored chips.

Chips of eight or nine different colors are usually sufficient to make the selected subcubes easily distinguishable. The corresponding products then are found by means of the labels on the edges of the plastic cube.

In Figure 2, the two bottom planes are $A$ and the two middle ones are $B$. The variables $C$, $D$, $E$, $F$ are arranged on each plane as on the top, each letter serving to label two rows or columns. It can be seen that any pair of horizontally or vertically adjacent squares differ in the value of just one variable. In this latter sense, one also may consider the opposite ends of any row, column, or vertical to be "adjacent." Then the description of subcubes is particularly simple. Every subcube is a "rectangular parallelepiped" with edges one, two, or four units long. Also, every such figure is a subcube.

In addition to the foregoing, maps may be used to:

(*a*). Synthesize "or-and," "or-and-or," and "and-or-and" forms.

(*b*). Rigorously minimize 2-stage diode circuits.

(*c*). Synthesize multioutput relay circuits.

(*d*). Determine whether any variable or negated variable is unnecessary to realize a given function.

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**M. Karnaugh** is with Bell Telephone Laboratories, Inc., Murray Hill, N. J.

# Pilot-Wire Relaying Utilizing the Product Differential Relay

R. I. WARD
MEMBER AIEE

D. W. GILMAN
ASSOCIATE MEMBER AIEE

**This pilot-wire relaying scheme has been designed to take advantage of the product characteristic of the type CFD relay. It operates as a variable percentage differential relaying device on light fault currents and for all practical purposes as a phase angle comparison scheme on heavy fault currents.**

A 138-KV solidly grounded transmission system is under construction in the metropolitan area of Chicago, Ill. The new lines in this system vary in length from 2 to 16 miles, some use cable, some are overhead, and others a combination of both. Several types of line terminations also are involved.

System studies showed that the requirements for line pilot-wire relaying on this 138-kv transmission system exceed those of the existing pilot-wire relaying schemes. The more important of these additional requirements are

1. The pilot-wire relaying scheme must not trip on through fault currents up to 20,000 amperes, symmetrical or offset. This requirement applies for different types of line terminations, also for combining different types of current transformers in the relaying scheme.
2. It must not trip on line charging current.
3. It must trip both ends of the lines on single-end feed currents of 2,000 amperes or greater.
4. It must perform satisfactorily on pilot wires up to 125 ohms resistance and 4 microfarads capacitance. This is equivalent to pilot wires up to 16 miles in length. These pilot wires may or may not be twisted.
5. It must provide means for isolating induced potentials up to 19 kv on the pilot wires. Calculations of induced potentials on the pilot wires for maximum fault conditions indicate induced potentials of 12 to 13 kv. Tests on a 66-kv line having similar characteristics verify these calculations. Pilot-wire cable used on this system will withstand approximately 20 kv for 1 minute.

The pilot-wire relaying scheme described in this article not only met these requirements but operated satisfactorily during tests on an artificial line on through faults in excess of 40,000 amperes. It also withstood a through fault of 22,000 amperes using 120/1 and 240/1 current transformers on the opposite ends of the line. The relays at both ends of the line had a positive restraining torque during these tests.

## DESCRIPTION OF RELAYING SCHEME

THE RELAYING SCHEME is presented graphically in Figures 1 and 2. Figure 1 shows the 3-phase test circuit and 3-phase current blending scheme. Figure 2 shows a single-phase test circuit and the main components of the relaying scheme.

The 3-phase test circuit simulates a 3-phase line equipped with mismatched current transformers. Both bushing and wound-type current transformers were intermixed for 3-phase tests as shown on Figure 1. The 3-phase current blending scheme provides a single-phase current from the 3-phase line currents. A similar type of current blending scheme has been used successfully with line pilot-wire relaying schemes for many years. It has the ad-

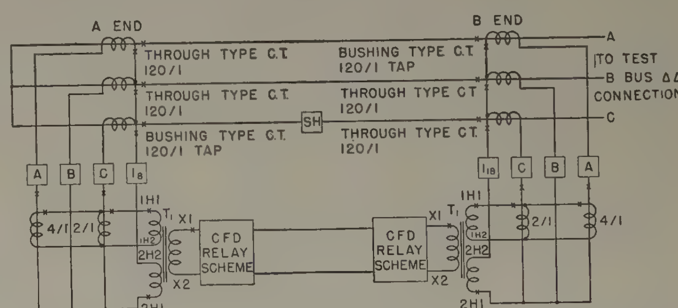


**Figure 1. Test connection for 3-phase tests on the CFD pilot-wire relaying scheme**

vantage of supplying a greater output current than the current phase sequence filters without placing an excessive burden on the line current transformers. This output is required to compensate for pilot-wire losses due to high pilot-wire capacitance. The phase blending scheme consists of $T_1$, and the 4/1 and 2/1 auxiliary current transformers. These current transformers are connected as shown in Figure 1. The auxiliary current transformer $T_1$ has two primary windings $1H1$-$1H2$ and $2H1$-$2H2$ and one secondary winding $X_1$-$X_2$. The primary winding $1H1$-$1H2$ is used for phase to phase faults and the primary winding $2H1$-$2H2$ is used for ground faults. The ratio of $T_1$ for phase-to-phase faults is 1/1 and for ground faults 4/1. The 4/1 ratio is used to reduce the relay scheme currents on ground faults. Ground faults of approximately 20,000 amperes are possible because of the solidly grounded 138-kv system. The phase blending scheme

Full text of paper 53-200, "A Pilot-Wire Relaying Scheme Utilizing the Product Differential Relay," recommended by the AIEE Committee on Relays and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer General Meeting, Atlantic City, N. J., June 15–19, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

**R. I. Ward** and **D. W. Gilman** are with the Commonwealth Edison Company, Chicago, Ill.

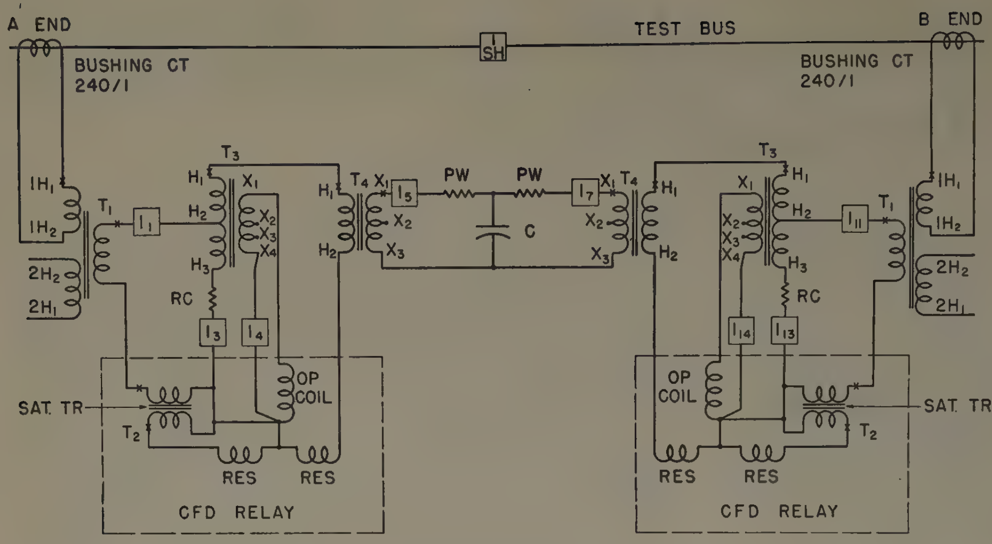


**Figure 2. Test connections for single-phase tests on the CFD pilot-wire relaying scheme. Squares indicate oscillograph recording positions**

does not provide the same relay sensitivity for all types of faults since it uses unequal ratio auxiliary current transformers to supply the single-phase component.

The current in the relaying scheme ($T_1$ secondary current or $I_1$) depends upon the types of line fault. The following table gives the $I_1$ current in per cent of secondary current of the line current transformers for the different types of faults or load currents:

| | Per Cent |
|---|---|
| *A* phase to ground | 50 |
| *B* phase to ground | 25 |
| *C* phase to ground | 75 |
| *A* to *B* phase | 25 |
| *B* to *C* phase | 50 |
| *C* to *A* phase | 25 |
| 3 phase | 43 |

It will be noted that there is considerable difference in relay sensitivity for the different types of faults. The final relay settings are based upon the least sensitive combination, that is, the 25-per-cent combination.

The type *CFD* pilot-wire relaying scheme is a circulating current scheme. On through faults or load currents approximately one-half of the single-phase component ($I_1$) flows over the pilot wires (through the pilot-wire isolating transformer $T_4$) and the other half flows in the local circuits, see Figure 2. The pilot wire component flows through the $H_1$-$H_2$ winding of $T_3$ and the local half through the $H_2$-$H_3$ winding of $T_3$. Since these currents are approximately equal in this differentially connected current transformer, the output of the secondary winding $X_1$-$X_4$ is essentially zero. The compensating resistor is used to assist in balancing the two primary currents in $T_3$. This compensating resistor compensates for the voltage drop in pilot-wire transformer $T_4$ primary winding and a 60-ohm pilot wire. This is sufficient to compensate satisfactorily for pilot wires from 0 to 120 ohms.

The two primary currents in the differential current transformer $T_3$ also are used to energize the two restraining coils of the type *CFD* relay. The pilot-wire component of current circulates through one restraining coil. The other restraining coil is supplied by the saturating transformer $T_2$ in the $I_1$ return circuit. The amount of restraining or contact opening torque on the moving element of the type *CFD* relay is proportional to the product of the ampere turns in the two restraining coils. The saturating current transformer $T_2$ is used to limit the current in one restraining coil of the *CFD* relay. This is done to limit the restraining torque sufficiently to permit the relay operating circuit (contact closing torque) to overcome the restraint on single-end feed internal line faults.

The operating coil circuit is energized by the $T_3$ secondary winding $X_1$-$X_4$. This current is proportional to the difference between the two primary currents, $H_1$-$H_2$ and

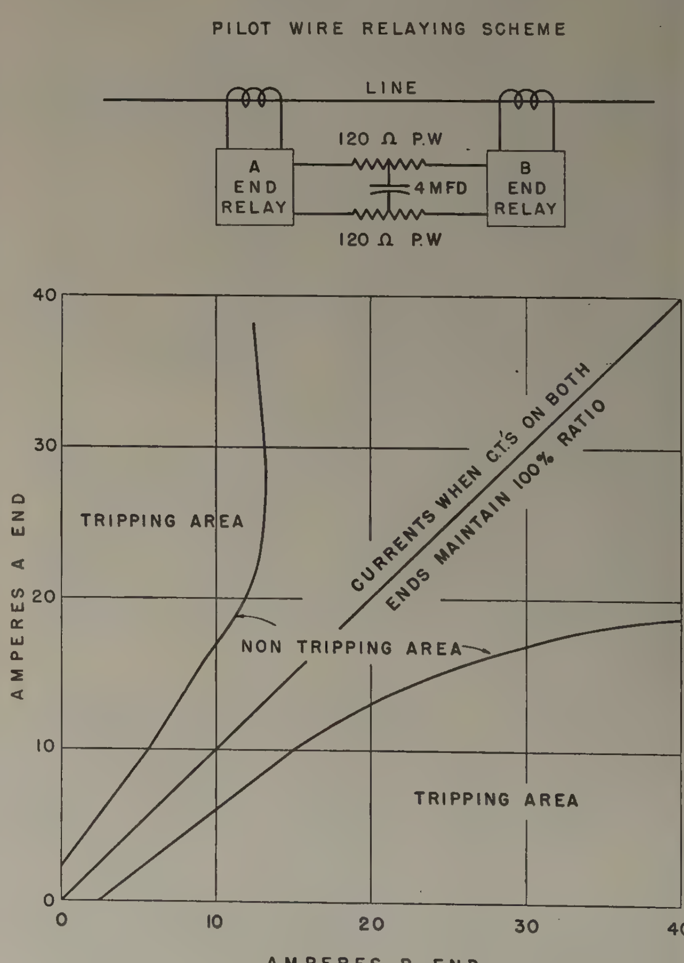


**Figure 3. Approximate relay characteristics showing the effect of the modified product restraining torque for 120-ohm pilots**

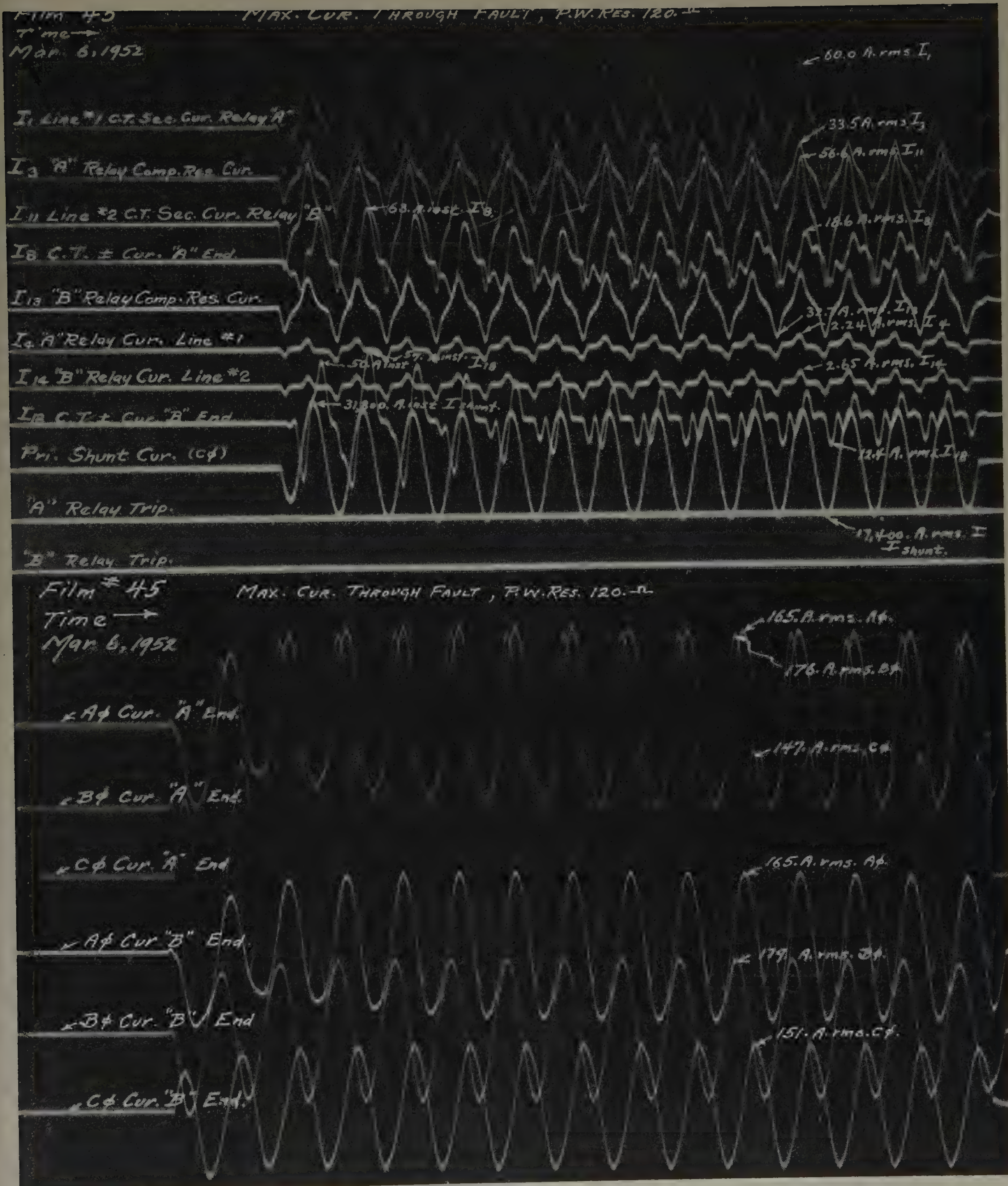


**Figure 4. Oscillograms showing currents and voltages in relay circuits during heavy 3-phase through fault**

$H_2$-$H_3$. The $H_1$-$H_2$ current is either zero or greatly reduced on internal faults. In this case $X_1$-$X_4$ current supplies the contact closing torque to close the relay trip circuit contacts. Since the $H_1$-$H_2$ current is either zero or small, the current in one restraining coil is also zero or small. This reduces the relay restraining torque to a negligible quantity and provides a very sensitive relay setting on internal faults.

The pilot-wire component of current is supplied to the pilot wires by means of the pilot-wire transformer $T_4$. This transformer serves two purposes. It provides a high-voltage insulation between the station wiring and the

high induced voltages on the pilot wires. It also reduces the pilot-wire burden by its impedance ratio.

The type *CFD* relay has a standard element; however it is remounted in a 2-element case. The additional space is required to mount the saturation transformer $T_2$ and the compensating resistor *RC*. The resistor originally was mounted externally as shown in Figure 2. In the latest design it is mounted inside the relay case.

The operating characteristics of the type *CFD* relaying scheme are shown in Figure 3. These curves are plotted in terms of line current transformer secondary currents at opposite ends of the line. The tripping areas are shown for the *A* end relay. It will be noted that the tripping values vary depending upon whether the *A* or *B* end is supplying the greater current. The minimum tripping value of the type *CFD* relay varies slightly depending upon which direction the current flows through its restraining coils. This is responsible for the difference in the two operating curves.

## TESTS

Three series of tests were carried out on the relaying scheme:

1. A 3-phase test using different types of line current transformers.
2. A single-phase test using bushing current transformers.
3. A single-phase test using a 240/1 and a 120/1 current transformer on opposite ends of the test line. This test was made on heavy fault currents to simulate a break in ratio of the current transformers on one end of the line.

The 138-kv lines will use 240/1 line current transformers; however, due to the lack of availability of sufficient 240/1 current transformers, the 120/1 transformers were substituted. The relay currents using the 120/1 current transformers are approximately twice that available under maximum fault conditions.

The tests were made at various current values simulating different system conditions. Tests also were made at approximately twice the fault current available on the system. These values covered a range up to 45,000 amperes.

A magnetic oscillograph was used to record currents, voltages, and relay contact closings. The measured points are indicated by the squares in Figures 1 and 2. The current designation in the squares conforms to the current designations on the oscillograms.

Oscillograph records of two heavy external faults and one heavy internal fault are included here. The first, a record of a heavy 3-phase external fault, is shown in Figure 4. This test was made under the following conditions:

1. Two bushing and four through-type 120/1 current transformers were connected in the test circuit as shown in Figure 1.
2. The pilot-wire resistance was 120 ohms per pilot

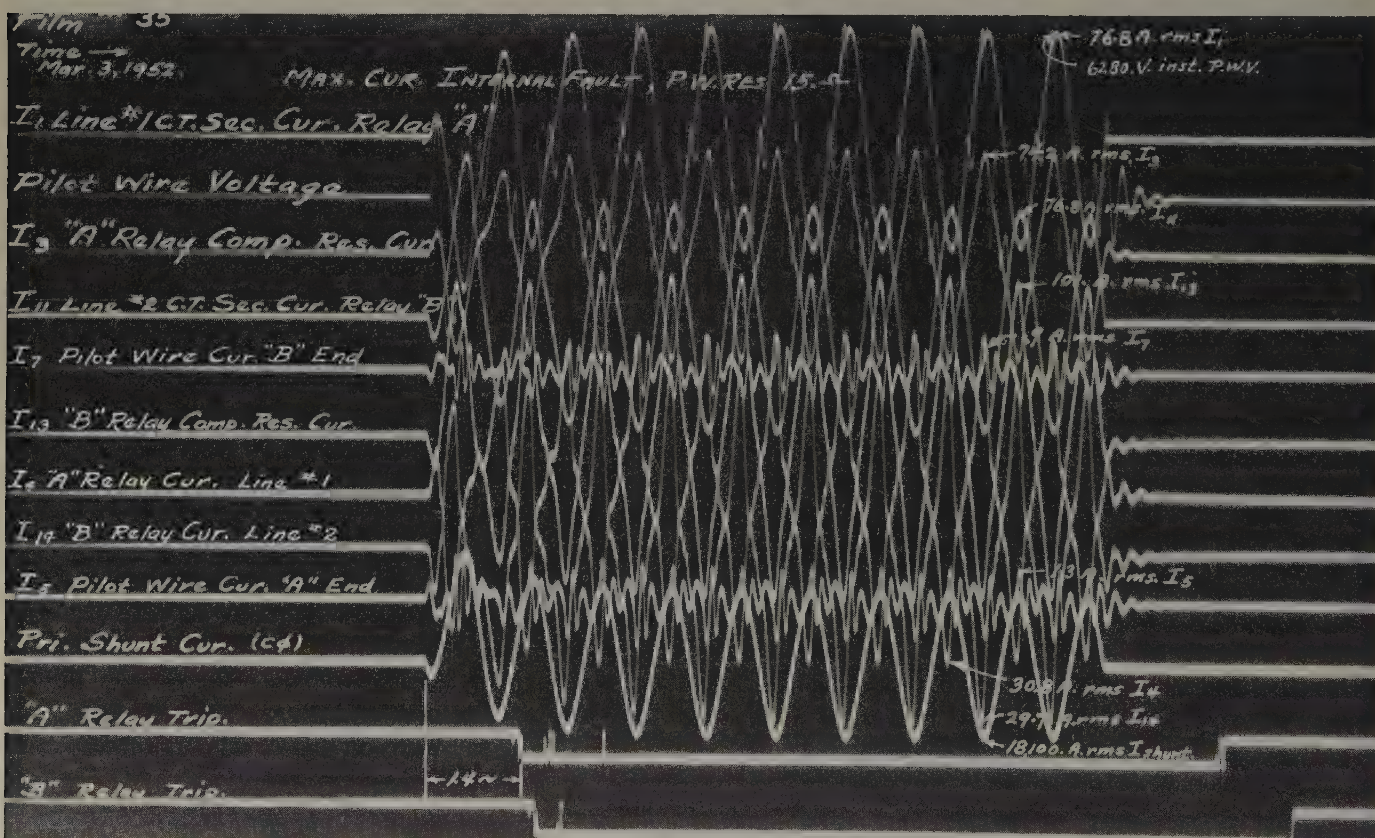


Figure 5. Oscillogram showing currents and voltages in relay circuits during heavy single-phase internal fault

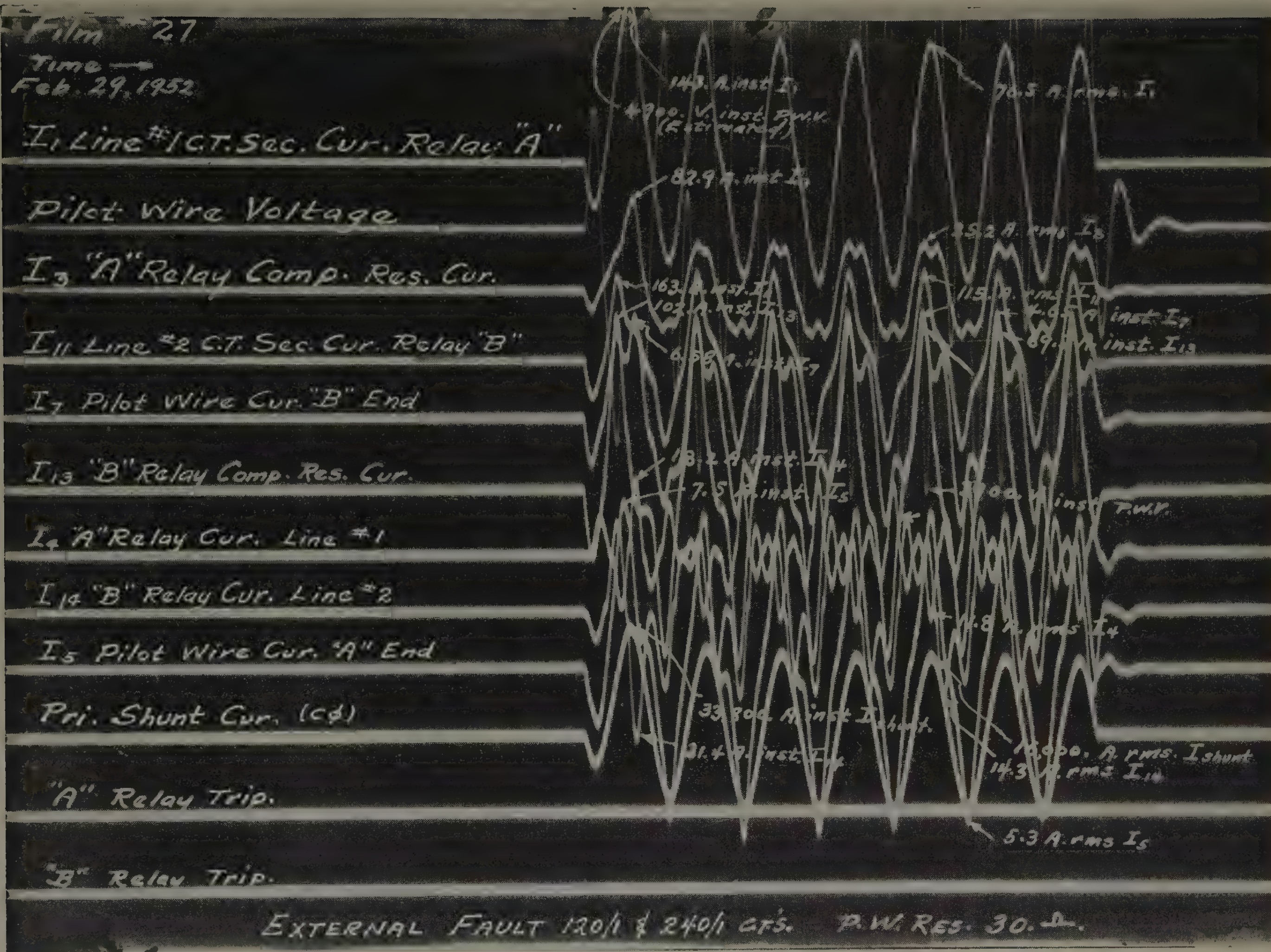


**Figure 6. Oscillogram showing currents and voltages in relay circuits during heavy through fault using 120/1 CT on one end of the line and using 240/1 CT on the opposite end**

wire. The pilot-wire capacitance was 4 microfarads. This is equivalent to a line 15 miles long.

3. The *CFD* relay was adjusted so that its contacts closed at 0.14 ampere. The restraining coils were not energized during this calibration.

The secondary currents of the line current transformers are shown on the bottom record of Figure 4. These current transformers withstood overloads as high as 34 times their rated current with very little core saturation.

The remaining measured currents in the pilot-wire relaying scheme are shown in the top record of Figure 4.

The second oscillograph record, Figure 5, shows currents in the various relay scheme circuits, the pilot-wire voltage, and the relay operating time during a heavy single-phase internal fault. For this test 240/1 line current transformers and 30-ohm pilot wires were used.

The pilot-wire voltage during this test exceeded 6,000 volts. While this voltage is not excessive for the present pilot wires, it was considered advisable to reduce it. This high voltage occurs on short pilot-wire installations where the pilot-wire capacitance is negligible. The pilot-wire voltage is reduced on the long lines by the shunt path provided by the pilot-wire capacitance. A center tap was provided in the final pilot-wire transformer $T_4$ to reduce the pilot-wire voltage on internal faults. The center tap is used for pilot wires of 2-microfarad capacitance or less and the full winding is used for pilot-wire capacitance above this value.

The contact closing time of the type *CFD* relay was approximately 1.5 cycles for this internal fault. This high-speed operation is desirable for removing a faulted line with the minimum disturbance to the system.

The third oscillogram, Figure 6, is a record of a heavy single-phase external fault using a 240/1 current transformer on one end of the line and a 120/1 current transformer on the opposite end. This test was made to prove the effectiveness of the product restraint characteristic. The same currents and voltages were recorded as in Figure 5. The high relay operating coil current is of particular interest. The operating coil current ($I_{14}$) in the *B* end of the line exceeded 30 amperes peak. The minimum relay contact closing setting with the restraining coils de-energized was 0.2 ampere rms for this test. Thus the peak current during the external fault was greater than 100 times the minimum operating current setting. The re-

straining torque on the moving element was sufficient to slip the moving element clutch in the contact opening direction.

## CONCLUSION

The scheme successfully met all five special requirements during the tests. The product characteristic of the *CFD* relay permits wide latitude in the choice of type of current transformers. Because its operating characteristic for large currents is essentially phase-angle comparison, the relays will not trip on heavy through faults even with different combinations and types of current transformers and most types of line terminations. The ratio of fault current from a single-end feed to line charging current is greater than 6 to 1; thus there was no problem presented by the second and third requirements. Two adjustments have been incorporated to obtain satisfactory performance for various lengths of pilot cables. Transformer $T_3$ has been tapped for short, medium, and long lines. Transformer $T_4$ serves to isolate induced voltages on the pilot wires, thereby meeting the final requirement.

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# Joint Use of Wood Pole Lines With Increasing Line Voltages

W. E. BLOECKER
MEMBER AIEE

W. R. BULLARD
FELLOW AIEE

**Although the joint use of wood poles by supply and communication companies has been established practice for well over 50 years, changing technologies in both the power and telephone fields has necessitated continuous review to provide successful co-ordination of facilities on the same pole line. The problems introduced by higher supply voltages are discussed.**

The joint use of wood poles, or, as it is more commonly referred to, joint use, is the use of the same pole line to support the wires or cables of both the power companies and the communication companies. A special term, joint crossing pole, is applied to the case where the wires of the two utilities are attached to the same pole at a point where their routes intersect. As the discussion progresses, it will be recognized that many of the considerations of joint use apply equally well to what are called conflicting rights of way which are situations where the physical arrangements of power and communication wires are such as to make contacts possible in the event of line troubles or during construction activities.

It is clear that the joint occupancy of poles, or situations involving numerous crossings of power and communication circuits, require added engineering consideration to assure the safety of the public, of utility workmen, and of property, comparable to that afforded by separate nonconflicting plants. What then are the reasons for entering into joint use construction? There are several important advantages which a single pole line offers over separate lines under many circumstances; for example:

1. In situations where, because of topography or other limitations, suitable separate nonconflicting rights of way either are not obtainable, or are difficult or expensive to obtain.
2. Accurate control of separations and other construction features affecting safety at crossings and other locations where proximity is unavoidable.
3. Elimination of objections to double lines by municipalities or other civic groups which ultimately might take the form of ordinances or other restrictive regulations.
4. Possibilities of economies in construction.
5. Conservation of pole timber now in short supply.

For reasons such as these, the joint use of pole lines to carry supply and communication circuits, started before 1900, has developed to the point where there are in the United States today some 11,000,000 poles doing this double duty, not counting the crossing poles. Of these jointly used poles, there are about 8,500,000 in urban areas, and about 2,500,000 in rural areas. Since 1945 the total number of jointly used poles has been increasing at the rate of about 500,000 each year.

In the beginning, practically all of the situations for which joint use appeared justified involved power voltages of less than 5 kv, and the protection arrangements of the telephone plant were designed accordingly. As a result, 5 kv came

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**W. E. Bloecker** is with American Telephone and Telegraph Company, New York, N. Y., and **W. R. Bullard** is with Ebasco Services, Inc., New York, N. Y.

to be considered the maximum supply voltage with which joint construction safely could be established. The greater part of urban joint construction today involves voltages less than 5 kv. However, with increasing loads, the power companies found it necessary to employ higher voltages. The continuation and extension of joint construction with these higher voltages involved a reappraisal of the reaction on noise induction and protection. That these considerations have been worked out effectively may be seen from the fact that most of the rural joint use today involves distribution voltages of 12 kv, and extending as high as 25 kv, while urban joint use with 13.2 kv is fairly common in some areas. There is a growing number of situations of joint use with 33 kv, some scattered cases of joint use with 44 kv (5 miles in one case), with 69 kv (2 miles in one case), and there is one situation where arrangements were worked out for something over 400 feet of telephone cable for joint use with 110 kv. This is not to say that all caution has been cast aside but rather that where proper co-ordinated protection has been applied, both to the power and to the communication systems, joint use well may represent the best engineering solution without reference to any arbitrary voltage limitation.

## NOISE CONSIDERATIONS

As far as inductive co-ordination is concerned, it might appear that the higher couplings resulting from the relatively close spacing of power and communication conductors add to the difficulties. However, the fixed relationship between the two types of plant results in a more uniform exposure which facilitates control of the coupling. In general, noise problems are no more difficult to solve than where the power and communication lines are at roadway separation.

In considering the effect of increasing voltage on power system influence—that is, its potentiality for impairing transmission on neighboring communication facilities—it may be said that under some conditions it will increase and under others it will decrease.

The circumstances under which power circuit influence is likely to go up when voltages increase are

1. When there are relatively large harmonics of the higher orders impressed on the distribution system usually at the source of power supply.
2. Where the loads are relatively light, at least during certain periods of the day.

The circumstances under which noise influence is likely to go down are

1. Where the waveshape of the power supply system is fairly good and the harmonic currents are of the lower orders: 3, 5, 7, and 9.
2. Where the transformer kilovolt-amperes per mile of line are fairly high, the reason being that transformer magnetizing currents are likely to control current waveshape on lower voltage lines, and these currents decrease as the voltage increases.

In any event the correction of an inductive situation involving a high-voltage distribution circuit is generally less difficult than one involving a low-voltage circuit for two reasons:

1. Harmonic currents tend to be smaller on the higher impedance circuits.
2. Where they are large enough to cause trouble, it is much easier to reduce their effect because shunt devices for high-impedance circuits are easier to design and cheaper to build than similar devices for low-impedance circuits.

## PROTECTION CONSIDERATIONS

The approach to successful safe operation of power and telephone circuits on the same poles or involving numerous crossings rests on two basic considerations:

1. Adequate structural arrangements to minimize the possibility of contacts occurring, and to provide safe working conditions.
2. Co-ordinated electrical protection arrangements for power and telephone facilities to minimize hazards to persons, and to limit plant damage in the event of accidental contact.

The broad basis for structural arrangements rests on the generally accepted standards of good engineering as set forth in the National Electrical Safety Code published by the National Bureau of Standards and approved by the American Standards Association. It is the result of contributions by engineers of the wire-using companies, and reflects their experience and best judgment at any given state of electrical development. This code, however, is no immutable law. In fact, it is now in its fifth edition, as industry has learned from experience what changes are desirable or necessary, and has recognized the latest technical developments. Organizational work is now under way looking to a new edition, which will include consideration of those aspects relating to voltage classifications and clearances, strengths of structures, and items which have called for extensive interpretation since the fifth edition was published.

The code allows considerable latitude in interpretation, and in order to arrive at sound construction practices the Joint Committee on Plant Co-ordination sponsored by the Edison Electric Institute (EEI) and the Bell Telephone System has issued a specification[1] designated as EEI *Publication M-12.* In general this publication outlines methods for attaching the two plants to the poles, and gives the requirements for pole strengths, guying, wire sags and tensions, and clearances, both above the ground and between the two plants. Specifications which provide for adequate working and climbing space for the workmen of both utilities also are included. As an example of keeping up with a changing art, *Provisional Report Number 32,** discusses proposals for further savings in pole timber by judicious reduction of clearance requirements. It is thought that as experience is gained with these proposals, they ultimately could be incorporated into *M-12* with such changes as seem desirable. Because of its nature, *M-12* has been incorporated in many joint use contracts, frequently by

* "Factors Which Influence Pole Height in Rural Joint Use of Poles." Provisional Report Number 32 Joint Development and Research Subcommittee, Edison Electric Institute, Bell Telephone System. (Available from either organization.)

reference, in order to permit changes resulting from technical developments to be incorporated in *M-12* and consequently in the construction practices without re-opening the contract itself.

Adequate electrical protection involves basically the two following requirements:

1. Prompt and positive de-energization of the power conductors in the event of contact with communication plant.
2. Establishment and maintenance of good low-resistance grounds on the communication plant.

Prompt de-energization is important to limit the duration of hazardous voltages on the communication plant so as to minimize the possibility of personal injury, and to limit the extent of plant damage. The low-resistance ground is important to assist in obtaining prompt de-energization, and also to minimize the magnitude of voltage rise on the communication plant before de-energization. Thus, it will be seen that the electrical protection involves the practices of both the power and communication systems, and the co-operative engineering and application of proper protection devices to the two systems is what is meant by the term co-ordinated protection.

## CO-ORDINATED ELECTRICAL PROTECTION

CO-ORDINATED ELECTRICAL PROTECTION involves consideration of a number of factors, some of which relate to the power system, and others to the communication plant, so that each particular situation needs to be reviewed as an individual case reflecting the particular conditions.

*Voltage of Power System.* From the standpoint of prompt and positive de-energization, it can be stated as a general principle that the higher the supply voltage, the better the situation. A couple of homely arithmetical examples will illustrate this point:

1. Assume a 4-kv circuit (2.4 kv to neutral) with 250-kva load per phase. The power load current would be slightly over 100 amperes which would mean that probably fuses or circuit breakers set to operate at about 200 amperes would be provided. In the event of accidental contact with telephone plant such that the total impedance of the fault circuit is around 10 ohms, the fault current would be about 240 amperes giving a small margin of current to operate fuses or circuit breakers.
2. With an increase to 12.5 kv (7.2 kv to neutral) with a load of 750 kva per phase, the full-load current again would be in the order of 100 amperes. However, an accidental contact would result in a fault current of 550 amperes (making allowance for the somewhat higher reactance of the supply transformer) thereby providing a substantial margin to insure prompt de-energization.

*Type of Power System.* The type of power system distribution has an important bearing on the assurance that de-energization will be prompt and positive under fault conditions. The multigrounded neutral system is the most favorable from this standpoint, since the frequent grounding of the neutral conductor together with the neutral conductor itself affords a low-impedance path for fault currents in the event of faults to neutral, or to other metallic structures or circuits associated with the neutral. The multigrounded neutral also provides a ready means of obtaining a good ground for telephone cables and protectors by suitable bonding.

In case of a unigrounded system whether the neutral conductor is carried along with the phase wires or not, a fault to ground completes a circuit back to the substation through the earth. The impedance of this fault current path may be relatively high, depending to a great extent on the ground contact resistance.

In the case of isolated delta systems in the event of a fault to ground of a single-phase conductor, the capacitance to ground of the unfaulted phase conductors provides the only path for fault currents. Therefore, in a single-phase fault to ground, the fault current is the leakage and charging current of the unfaulted conductors. Generally, the smaller the system and the lower the voltage, the smaller will be the resulting fault current. The questions to be answered in this case are whether or not such fault current is sufficient to operate the power system protection equipment and, if not, whether the voltage on the communication plant is held low enough through low-impedance grounds to be safe.

The occurrence of a single fault on an isolated delta system increases the voltage to ground of the nonfaulted phase wires, and the breakdown of another conductor often follows. In the event of a double fault, the situation is similar to that of the unigrounded system. In some delta systems grounding banks are used at the supply substation. From the standpoint of co-ordinated protection, this arrangement modifies the isolated delta system to a form more or less like that of the unigrounded system, depending upon the characteristics of the grounding means.

*Type of Telephone Plant.* Two types of telephone plant, namely, cable and open-wire, may be involved in joint use with power systems.

In the case of cable, the impedance of any fault to ground is kept low by frequent bonding of the sheath to the neutral conductor of a multigrounded neutral system where such a system is present. In other cases, a ground may be obtained by the connection of the cable sheath to the sheath of buried or underground cables. Bonding to other extensive underground structures, such as water pipe systems, also is often effective in lowering the impedance to ground. With either of these methods of grounding to extensive underground systems, the cable sheath corrosion aspects need to be given careful consideration.

For open-wire situations where voltages above 3 kv to ground are encountered, carbon gap devices designed to break down at about 3 kv are connected between each wire and ground at approximately 1/2-mile intervals. A feature of the design of these devices is their ability to handle large amounts of current. For example, in the case where the power system reclosers operate three times before de-energizing permanently, the device is able to carry three successive shots of 600 amperes of 1-second duration each and up to 1,300 amperes for durations of

2/10 second. To be effective the resistance of the ground connections must be low and here again the multigrounded neutral, where available, is most useful.

*Characteristics of Power Protective Devices.* Power protective devices may have several forms and may involve, particularly in the case of transmission circuits, rather complex arrangements. For distribution circuits, however, they usually consist of fuses or circuit breakers, the operation of which depends on current in individual power conductors. For practically all distribution circuits, the speed of operation depends on the ratio of the fault current to the expected full-load current; the higher this ratio, the faster the operation. Considering the requirements for co-ordinated protection, it will be clear that the objective is to have the fault current sufficiently high with respect to full-load current so that prompt de-energization is practicable, and to have the de-energization equipment such as to take advantage of this situation.

*Length and Location of Exposure.* The length and location of the exposure with reference to the substation has an important bearing on the performance of co-ordinated protection. The most critical point at which a fault may occur is where the fault current is at a minimum compared to the rating of the fuse or setting of the circuit breaker relay which protects that part of the power circuit, and consequently where the de-energization will be the slowest expected.

There will be other possible points of contact where the fault currents may be substantially higher, but in these cases the speed of operation of fuses or circuit breakers will be higher and the total energy dissipated at the fault may be no greater than it would be with the lower fault current at the critical point.

Generally, detailed consideration of the factors affecting co-ordinated protection is given only in the case of new and unusual situations. Usually this only involves assuring that the power circuit will de-energize promptly with a fault at the most critical location. Where the telephone plant is well grounded, it is not necessary to take its impedance into account in these calculations. But once the facts have been developed by a particular power company and telephone company, agreement can be reached on an area basis and further studies of specific cases falling within the area of agreement are not required.

## FIELD EXPERIENCE

A MEASURE of the satisfactoriness of joint use arrangements in any voltage range is the experience of the utilities from the standpoint of electrical accidents to personnel and plant damage. An analysis of electrical accidents indicates that there is no significant difference between what has been called in the past normal joint use and so-called higher voltage joint use. It is interesting that most of the accidents occur in connection with construction activities and are of such nature that their occurrence cannot be related to voltage. The type of accidents which do occur unfortunately result too frequently from lack of attention to ordinary safety precautions and to failure to observe carefully thought-out working practices.

In so far as telephone plant damage is concerned, experience indicates that there is little relationship between the extent of the damage and the voltage on the joint use lines. This results, to a large extent, from the more favorable de-energization characteristics of the higher voltage systems.

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# "Snubber" Is Biggest Silencer Ever Built

At the right is what Burgess-Manning Company engineers believe is the biggest silencer ever built. Measuring 74 feet in length, 12 feet in diameter, and weighing an estimated 70,000 pounds, this silencer was designed to silence the exhaust of a 5,000-kw simple-cycle gas-turbine generating unit installed in a Midwestern utilities company. This "Snubber" was so big it had to be shipped in three sections. It was designed and built by Burgess-Manning Company, specialists in silencing intake and exhaust noises from steam exhausters and ejectors, compressors, and vacuum pumps. Many of these silencers have important additional functions such as spark arresting, air cleaning, heat recovery, and surge control.

# Shunt Capacitors in Large Transmission Networks

E. C. STARR
FELLOW AIEE

E. J. HARRINGTON
ASSOCIATE MEMBER AIEE

IT IS WELL KNOWN that the most efficient operation of a power distribution network is obtained when the power factor of the load throughout the network is approximately 100 per cent. Transmission lines, however, when operated at the loads and voltage levels of maximum economy, require large amounts of reactive kilovolt-amperes (kvar), particularly at the load ends. The generator-end component of this reactive usually can be supplied most economically by the generators.

Extensive studies such as those illustrated in Figures 1 and 2 have shown that, if the terminal voltage ratios of best economy are employed, practically all of the reactive requirements of the load-end and of intermediate stations can be supplied at minimum cost by shunt capacitors. Proper choice of the ratio of receiving- to sending-end voltage, combined with a normal receiving-end transformer tap range, will permit control of the receiving-end voltage over the no-load to full-load range by switched shunt capacitors with no necessity for shunt reactors.

Figure 1 gives the characteristics of a fairly long, heavily loaded, 230-kv transmission circuit. It will be noted that the efficiency improves rapidly as the level of the receiving-end voltage increases in respect to that at the sending end. Figure 2 shows that shunt capacitors provide the minimum costs.

Capacitors may be applied at any voltage level providing the proper switchgear is selected. Economic studies of the Bonneville Power Administration transmission system have indicated that, in many cases, best economy is attained by applying the capacitors to the 115-kv bus. In some cases, where large amounts of reactive is required, application at the 230-kv level is indicated. The economy of application at these levels could be improved substantially by the development of suitable low-cost switchgear.

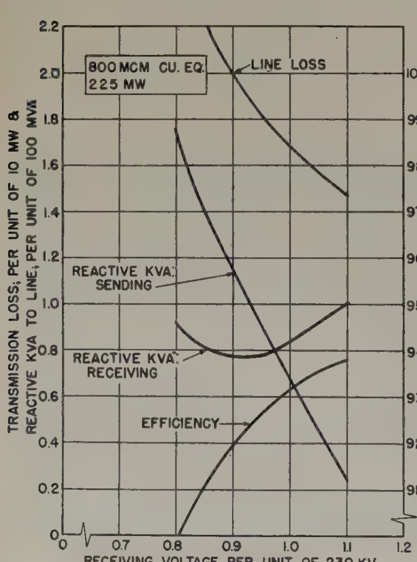



**Figure 1. High-voltage transmission reactive requirements and efficiency as affected by receiver voltage. Line: 175 miles, 230-kv construction. Sending voltage 242 kv. No sending-end transformer**

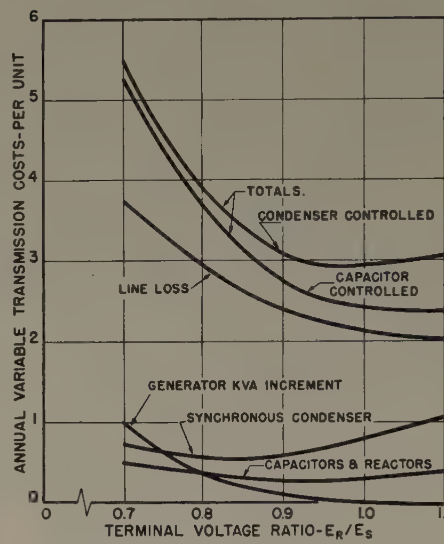



**Figure 2. Total and component variable transmission costs for typical moderate-length transmission line. Load range: 35- to 150-per-cent surge-impedance equivalent. Load factor 75 per cent**

The Bonneville Power Administration has to date 872,500 kvar of capacitors installed. Of this total 125,500 kvar are 115-kv installations, 627,300 kvar are rated 13.8 kv, while the remaining 119,700 kvar are 230-kv series capacitor installations. Total service equals 2,599,300 kvar years. Total failures to date equal 9,610 kvar. Approximately 7,110 kvar of this total failed by causes which it is believed the manufacturers now have eliminated.

The Bonneville Power Administration has conducted numerous tests on low- and high-voltage breakers to determine their interrupting performance while switching shunt capacitor banks. Banks of 13.8-kv capacitors equivalent to 50,000 kva and 115-kv groups equal to 40,000 kva have been switched. Breakers whose interrupting performance is restrike free usually will give good service.

Restrikes preceded by more than 1/4 cycle of current zero can produce transient overvoltages across the capacitors and on the system. Failures of line insulation may result. Oil circuit breakers, which restrike when switching parallel groups of capacitors, are subject to severe damage to the interrupting members. Magnitudes and frequencies of the currents between capacitor groups are very high under such conditions, particularly so for the high-voltage capacitor installations. Air and air-blast breakers, because of the elasticity of the interrupting medium, are not as prone to damage.

In order to insure against transient overvoltages across the capacitors and on the system and to eliminate the major source of breaker damage, Bonneville Power Administration specifications for capacitor breakers require that interruption be free of restrikes.

Digest of paper 53-340, "Shunt Capacitors in Large Transmission Networks," recommended by the AIEE Committee on Transmission and Distribution and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Pacific General Meeting, Vancouver, British Columbia, Canada, September 1–4, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

**E. C. Starr** is with Oregon State College, Corvallis, Oreg., and **E. J. Harrington** is with Bonneville Power Administration, Portland, Oreg.

# Analyzing Harbor Water and Earth Temperatures

W. N. McDANIEL E. F. WOLF
MEMBER AIEE

In the engineering studies of a possible installation of submarine cables at some depth below the Baltimore Harbor, data were required on thermal diffusivity and variations of ambient earth temperatures at various depths throughout the year. From measurements over a 20-year period, certain facts about the general character of the temperature variation of the water at the bottom of the Baltimore Harbor are known: (1) The average annual water temperature at the bottom of the harbor, is within a few degrees of the average annual air temperature in Baltimore. (2) The water temperature closely follows in magnitude, but lags behind the mean daily air temperature.

The determination of the seasonal variations in the ground may be considered to be a problem in heat conduction in a semi-infinite, homogeneous, isotropic solid. When the boundary temperature, $T_B$, which, in this case, is the temperature at the surface of the earth or at the earth-water interface, is a periodic function of time, $t$, of the general form

$$T_B = B_0 + B_1 \sin(\omega t + \epsilon_1) + B_2 \sin(2\omega t + \epsilon_2) + \ldots \tag{1}$$

the steady state solution for the temperature, $T$, at any time, $t$, and any depth, $z$, below the surface is

$$T = B_0 + B_1 e^{-\frac{\omega z}{\sqrt{2\omega\kappa}}} \sin\left(\omega t + \epsilon_1 - \frac{\omega z}{\sqrt{2\omega\kappa}}\right) + B_2 e^{-\frac{2\omega z}{\sqrt{4\omega\kappa}}} \sin\left(2\omega t + \epsilon_2 - \frac{2\omega z}{\sqrt{4\omega\kappa}}\right) + \ldots \tag{2}$$

where $\kappa$ is the thermal diffusivity, $B_0$ is the annual mean temperature, and $B_1$ and $B_2$ are constants. $\omega$ is $2\pi$ times the frequency.

Equation 2 indicates that the temperature at any depth is a periodic function with the same period as the temperature at the boundary, since the same type of periodic terms occur in both equations 1 and 2 with two significant differences. Each term of the equation for $T_B$ occurs in $T$ with the addition of a phase angle directly proportional to the depth. This indicates that there should be a progressive lag in temperature with increasing depth, which is in agreement with experimental observation. Also, each term of $T$ has a negative exponential term containing depth, $z$.

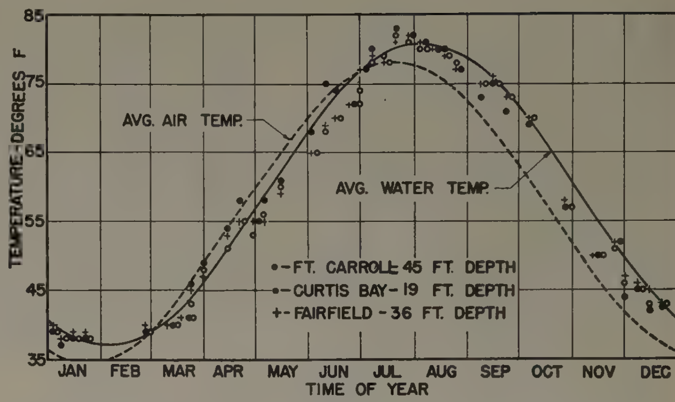



**Figure 2. Water temperature at floor of harbor compared with 45-year average air temperature**

In cases where the third and higher terms of equation 1 are small enough to be disregarded, the boundary temperature varies sinusoidally. Then the temperature, $T$, likewise varies sinusoidally, lagging in time and decreasing in amplitude with increasing depth. At great depths the temperature, $T$, approaches the constant $B_0$, the average annual air temperature.

Figure 1 shows the temperature of the earth under the Baltimore Harbor floor, calculated by equation 2 using a value, $\kappa = 0.359$ square feet per day. The calculated curves fit the experimental data well, except for the first few feet of the soft bottom where the fit is only fair.

The method of analysis developed for this study may be applied where the boundary variations in temperature and the diffusivity are known. The diffusivity may be evaluated experimentally by temperature measurements at one or more depths extending over sufficient time to establish phase relations between the temperature at the surface and at some depth. The value of $\kappa$ used in this study was obtained from such measurements over a period of 6 months. The curves drawn from these equations using this constant agreed satisfactorily with the experimentally measured temperatures up to a depth of 15 feet for the subsequent period of $1^1/_2$ years.

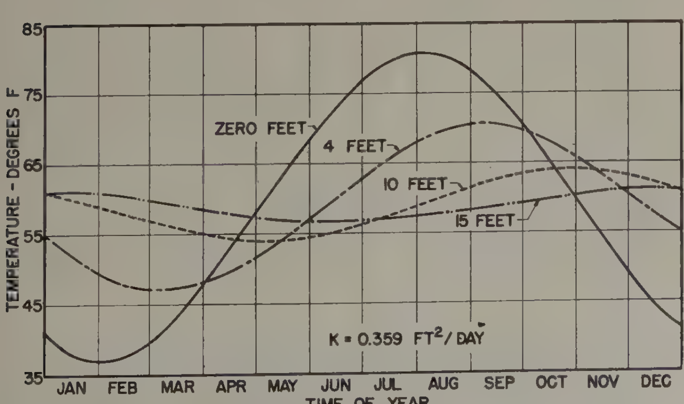



**Figure 1. Calculated temperature of ground under the Baltimore Harbor**

Digest of paper 53-391, "A Method of Analysis of Annual Variations of Harbor Water and Earth Temperatures," recommended by the AIEE Committee on Insulated Conductors and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Kansas City, Mo., November 2–6, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

W. N. McDaniel and E. F. Wolf are with Consolidated Gas Electric Light and Power Company of Baltimore, Baltimore, Md.

# Magnetic Amplifiers in D-C Conversion Stations

W. A. DERR
MEMBER AIEE

E. J. CHAM
MEMBER AIEE

D-C POWER is required in many industrial, mining, and railway applications. Most of the d-c power for these applications is provided by mercury-arc rectifiers. A relatively small percentage of d-c power is provided by rotary converters and motor-generator sets. Direct voltages ranging between 250 and 3,000 volts are used for these applications.

For instrumentation, control, and protection of a-c circuits, potential and current transformers are used to eliminate the necessity of carrying high voltages or currents to switchboards on which are mounted the required instruments, relays, and control devices. In d-c applications, shunts have been used to eliminate the need of carrying high-current circuits to the switchboard. However, prior to recent developments in the magnetic amplifier field there has been no method of isolating d-c circuits. This has required special precautions on d-c switchboards to protect operating personnel and prevent insulation breakdown. The problems involved in personnel protection and insulation have been particularly acute at voltages of 600 volts and above.

Relatively recent developments with magnetic materials and metallic rectifiers makes possible the manufacture of magnetic amplifiers which have essentially linear transfer curves and which are essentially independent of changes in load resistance and supply voltage over a wide range. With these desirable features, magnetic amplifiers can be applied in d-c conversion stations to provide complete isolation and adequate insulation from high direct voltages for instrumentation, protection, and control circuits. In addition, the isolation obtained with magnetic amplifiers simplifies some problems and provides a solution for other problems of instrumentation, protection, or control. The fact that alternating voltage is required for operation of a magnetic amplifier is no disadvantage in a d-c conversion station, since alternating voltage is always available.

Figure 1. Simple-type magnetic amplifier for low-energy output

In d-c conversion stations, currents of large magnitude are encountered. A small magnetic amplifier as shown in Figure 1 can be used to provide an isolated output which is proportional to the current to be measured, if the control winding of the magnetic amplifier is connected so as always to receive a fixed small percentage of the total current.

Figure 2 shows method of obtaining a d-c output from a magnetic amplifier which is proportional to the direct current in the circuit to be measured. Shunts are designed to have negligible change in resistance with change in temperature. With reference to Figure 2, the control winding circuit of the magnetic amplifier must have negligible temperature coefficient if the same proportionality of magnetic amplifier control current to total current to be measured is to be maintained. The division of current between the shunt and the control circuit of the magnetic amplifier can be kept essentially constant over a wide range of temperature by the use of Manganin wire in the magnetic amplifier and calibrated short copper leads between the shunt and the magnetic amplifier. The use of short shunt leads is no disadvantage since for isolation purposes it is desirable to locate the magnetic amplifier as close to the shunt as possible.

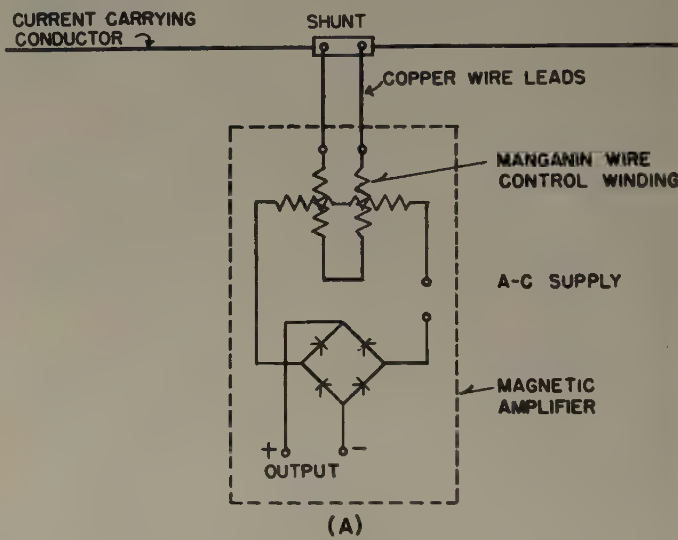



Figure 2. Magnetic amplifier connection for measuring current flow

Digest of paper 53-26, "Magnetic Amplifier Applications in D-C Conversion Stations," recommended by the AIEE Committee on Substations and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 19–23, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

W. A. Derr and E. J. Cham are with Westinghouse Electric Corporation, East Pittsburgh, Pa.

# Automatic Tripping for Turbine-Generator and Boiler Protection

H. A. BAUMAN
MEMBER AIEE

J. M. DRISCOLL

P. T. ONDERDONK

R. L. WEBB
FELLOW AIEE

**Although automatic protection of electric equipment has been standard practice for many years on electric power systems, it has not been applied as often to turbines and boilers in central stations. Its extension to the entire boiler–turbine-generator unit is described here.**

THE CONCEPT OF the entire protective system is based on the prevention of serious damage to the equipment by immediate detection of abnormal conditions and automatically tripping out the equipment. The new Astoria (N. Y.) Generating Station is shown in Figure 1 and a general cross section appears in Figure 2. All of the elements of the new over-all protective system as applied to the latest units are represented in Figure 3.

The protection of the electrical end of the unit is coordinated with that of the boiler and turbine so that troubles in the system will cause complete or partial shutdown of the entire unit as may be demanded by the type of failure involved.

## TURBINE-GENERATOR AND BOILER PROTECTION

1. *Thrust Bearing Failure.* In the operating experience of Consolidated Edison with main unit turbine generators, journal bearing failures have been practically nonexistent. However, there have been quite a few cases of thrust-bearing failures traceable to design, loose thrust collars or locking devices, internal fouling, or damage in the steam path.[1] In the thrust failures experienced, the normal oil outlet temperature from the bearing was not sufficiently responsive to the thrust-bearing metal to warn the operator in time to take steps to prevent machine damage. Consolidated Edison pioneered in the use of thermocouples inserted in the metal backing of the babbitted thrust shoes to give fast response to changes in thrust-bearing metal temperature. Experience over several years with such thermocouples, both on main units and auxiliaries, has been so successful—even to actual load-limiting, governored by thrust-bearing metal temperature—that it was felt the time had come to have built an automatic warning and trip device actuated by these thermocouples.

Experience in the operation of thrust bearings with thermocouples shows that extremely light wiping or scribing of the babbitt occurs at 200 degrees Fahrenheit. Therefore the devices are set to alarm at 10 degrees Fahrenheit above normal operating temperature and to trip at 190 degrees Fahrenheit. The protective device used for this purpose consists of a trip controller actuated by thermocouples inserted in each face of the thrust bearing. The thermocouples are installed as shown in Figure 4. One thermocouple in each thrust face is connected to a temperature recorder, one to the trip controller, and one is retained as a spare. The temperature recorder is provided with contacts for the warning alarm circuit and the trip controller is provided with contacts for the trip circuit.

2. *Damage From Excessive Vibration.* Should an unattended turbine begin to vibrate excessively from one of several causes, such as heavy rubs or loss of material from the spindle, it quickly would become severely damaged. Therefore, it is Consolidated Edison's thinking to provide a robot operator in the periods of time between the patrol operator's examinations to protect the machine against such contingencies by providing a vibration velocity type of pickup on one of the turbine-bearing pedestals. Vibration tolerances for 3,600-rpm turbine generators indicate that the pedestal vibration amplitudes of these units should be less than 0.5 mil horizontally 90 degrees from the shaft. Shaft vibration amplitudes will exceed those of the pedestal. Pedestal vibration amplitudes higher than 0.5 mil should be corrected by balancing at the earliest opportunity. The pickup devices have been installed and set to warn at pedestal vibration of 1.0 mil or higher and to trip the unit for pedestal vibrations of 3.0 mils or more.

Vibration protection also is provided on the generator

Figure 1. Astoria generating station

Full text of paper 53-388, "Protection of Turbine-Generators and Boilers by Automatic Tripping," recommended by the AIEE Committee on Power Generation and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Kansas City, Mo., November 2–6, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

**H. A. Bauman, J. M. Driscoll, P. T. Onderdonk,** and **R. L. Webb** are with the Consolidated Edison Company of New York, Inc., New York, N. Y.

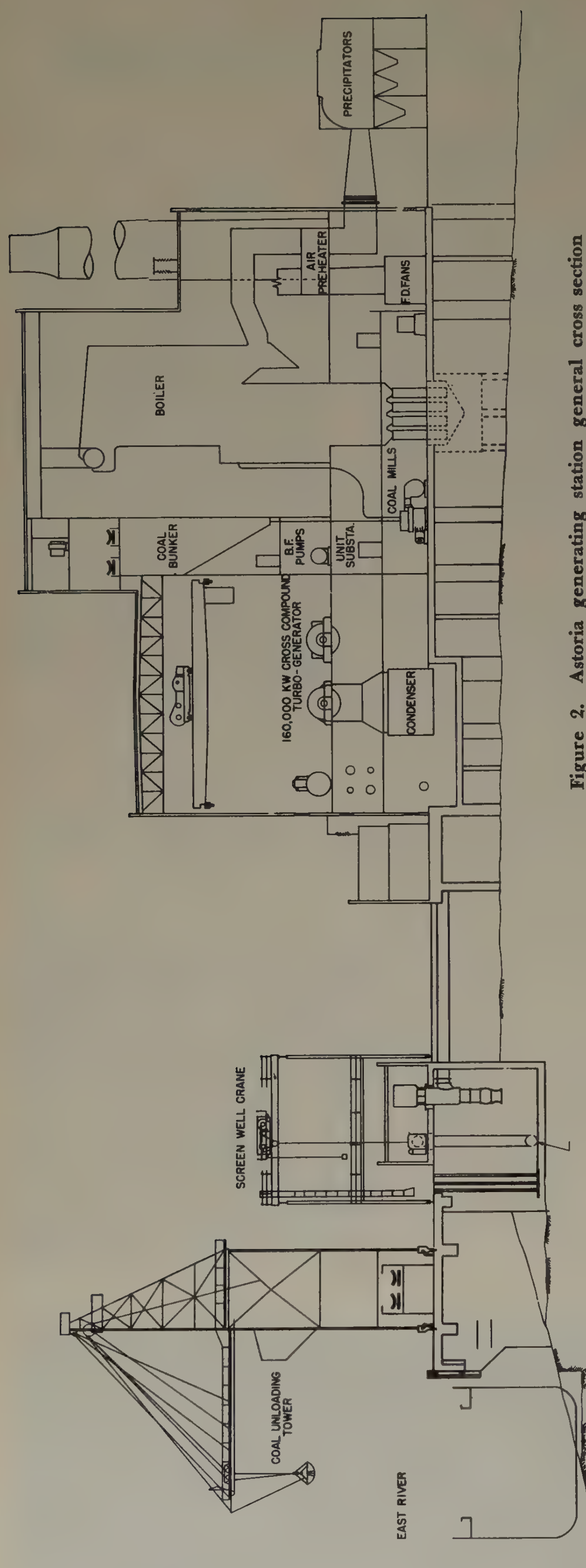



**Figure 2. Astoria generating station general cross section**

by a similar pickup device located on the outboard bearing end bell. Aside from vibration which may occur in the generator rotor for mechanical reasons, such as the failure of a generator cooling fan, one of the most serious types of faults which can cause severe vibration in the rotor of the generator is a double winding ground. Winding grounds of this type will by-pass current from a part of the field winding, causing vibration due to the unbalanced magnetic pull on the two sides of the rotor. In addition to this, short-circuited currents on one side of the rotor may cause enough rotor surface temperature difference to develop a small curvature in the shaft, which of itself may cause excessive vibration.

The vibration relay protection for the turbine and generator actuate separate relays which are provided with contacts for the trip circuits.

Vibration relay protection was developed[2] and built by Consolidated Edison in 1943. It has been used mainly as a portable protective device to be applied on a machine, once a single field winding ground has developed. The original device uses electronic tubes. One of the manufacturers improved on the design by eliminating the electronic tubes and by simplifying the electric circuits. This improved device has been in operation since 1952 on a large unit at East River and is shown in Figures 5 and 6. This equipment provides for tripping at 3 mils. The warning alarm is given by way of the manufacturer's turbine supervisory vibration recorder at 1 mil.

3. *Protection Against Exhaust Hood and Condenser Shell Damage.* Because of the necessity of using spray water cooling in the low-pressure exhaust end of 3,600-rpm units to maintain moderate temperatures at low loads in this location, and with the possibility of spray water failure and resultant high temperatures causing local turbine exhaust casing and condenser shell stresses, the turbine and condenser manufacturers recommended the installation of temperature alarm and Consolidated Edison added the tripping feature.

The alarm is set for 10 degrees Fahrenheit above normal operating temperatures and the trip for 190 degrees Fahrenheit. The protective device for this purpose consists of two thermocouples in the exhaust end of the casing of each low-pressure element which respond to steam temperature. One thermocouple in each casing is connected to a temperature recorder and the second thermocouple to a trip controller. The recorder is provided with contacts for an alarm circuit and the controller with contacts for a trip circuit. A spare well is provided in each case for calibration purposes.

4. *Damage From Loss of Vacuum.* The usual rupture diaphragms are provided in the exhaust shells to prevent positive pressure within the exhaust shell on loss of circulating water. To trip the machine well in advance of the disk rupturing, a device actuated by vacuum is used. This protective device is provided with contacts for a warning alarm at a vacuum of 27 inches of mercury and also contacts for tripping which are set to operate at a vacuum of 20 inches of mercury. In connection with the relation of item 3 and item 4, and their trip settings, there is an apparent inconsistency in that loss of spray cooling water at low loads (item 3) will result in a machine trip-out at 190 degrees Fahrenheit, while the loss of circulating water will result in a machine trip-out via a vacuum of 20 inches of mercury, or about 160 degrees Fahrenheit.

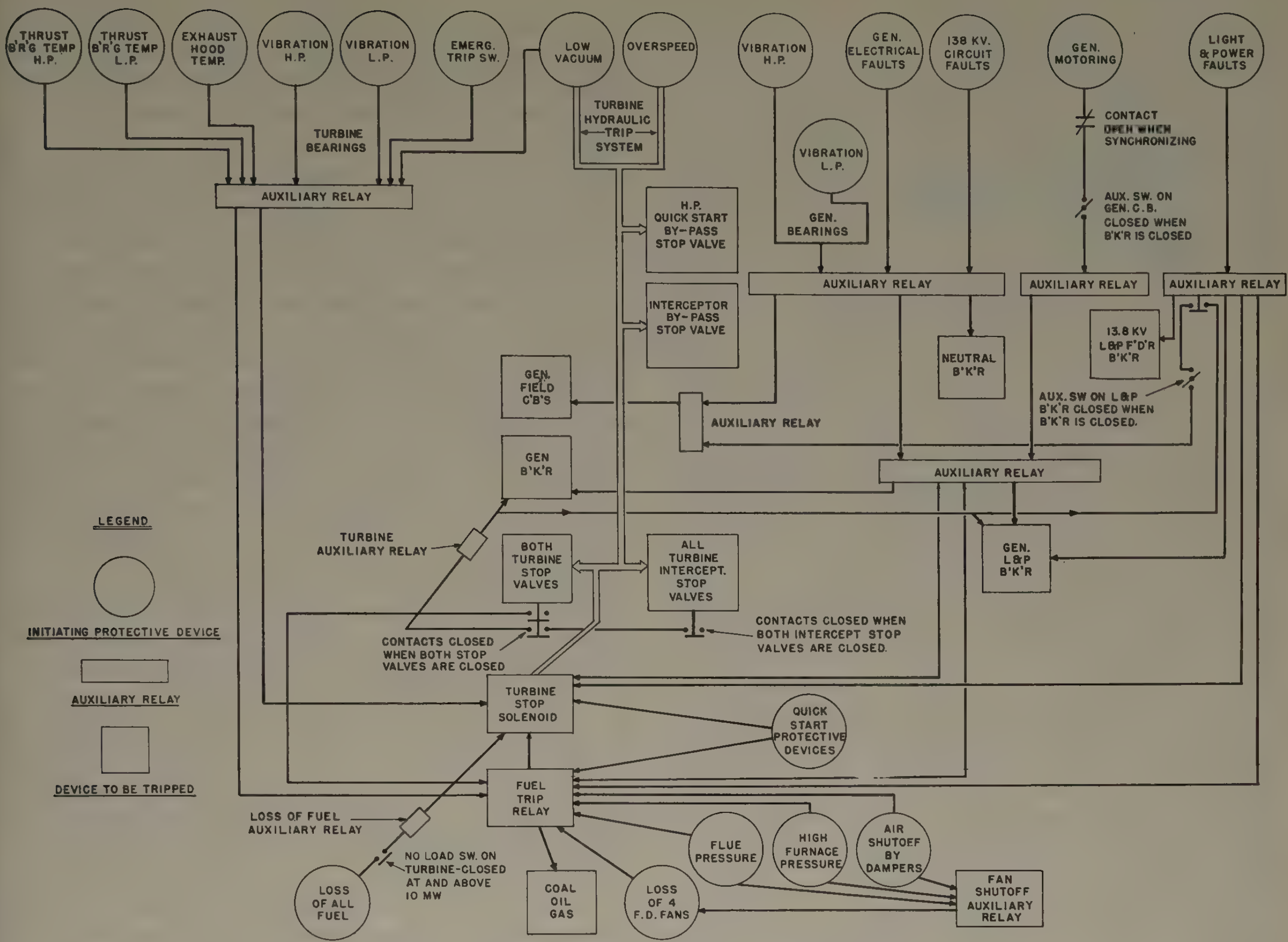



**Figure 3. Boiler–turbine–generator over-all protection**

This situation comes about through the exhaust temperature trip being an outgrowth of the manufacturer's alarm for exhaust high temperature and being a device to protect against high local temperatures in the exhaust hood due to reheating by windage, with temperatures remaining normal in the condenser shell, whereas the vacuum trip set at 20 inches is to protect against overpressure throughout the entire condenser and exhaust hood structure. Therefore the temperature prevailing at the time of vacuum tripping (160 degrees) still will be within the range of steam jet air removal capacity and will not introduce any appreciable delay in restoring the unit to service.

5. *Damage From Excessive Overspeed.* The manufacturer's usual overspeed devices, actuated by centrifugal forces, trip the main turbine stop or throttle, the main governor valves, and the reheat stop valves and reheat intercept valves.

6. *Quick Starting.* A safe method of quick starting turbine-generators[3] and boilers* was pioneered by Consolidated Edison. Our new reheat units will be the first to be equipped with a quick starting by-pass around the main and reheat cylinder to the condenser for the purpose of establishing mass steam flow through the superheater and reheater to a point where both main steam and reheat steam temperatures are approximately 100 degrees Fahrenheit above the chest metal temperature of the respective cylinders before opening the turbine control valves. Automatic trip devices are provided to take the boiler and turbine out of service in event of failure of automatic desuperheating devices, loss of circulating water, excessive temperatures in the high-pressure or intermediate-pressure turbine exhaust casing, and loss of control air pressure during the starting process.

7. *Generator and Transformer Differential.* Each generator and each transformer is provided with an individual current differential relay, in accordance with usual practice. In addition, an over-all differential relay including the circuit from the generator neutral to the 138-kv circuit breaker is provided as backup on the other four sets of differential protection. Incidentally, this is the only differential relay which applies to short circuits in the 13.8-kv metal-clad bus gear and to the 138-kv connections from the transformers to the high-voltage circuit breakers.

8. *Generator Ground.* The high-pressure generator neutral of each machine at Astoria will be grounded through a reactor and a circuit breaker. The reactor is applied

* Quick Starting of Large High-Pressure, High-Temperature Boilers, by J. C. Falkner, American Society of Mechanical Engineers (New York, N. Y.), Paper Number *52-A-120*.

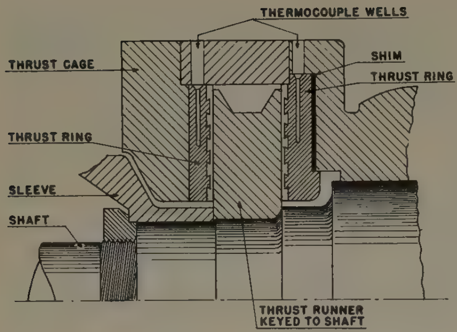
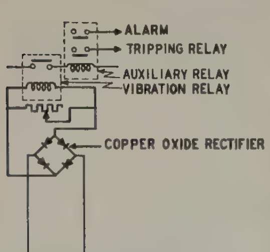



**Figure 4 (left). Thrust - bearing thermocouple installation — typical section**

for the purpose of preventing generator terminal ground fault currents from exceeding 3-phase terminal short-circuit current values. A generator neutral ground relay is connected to a current transformer in the generator neutral circuit breaker. The ground relay acts as backup protection to the normal differential relays which are provided for "first line" protection. This relay also backs up the protection which will be described later for the 13-kv auxiliary supply circuit when that circuit is operating from the generator.

9. *Loss of Field for High- and Low-Pressure Generators.* A type of loss-of-field protection[4] which measures the leading reactive current or leading reactive kilovolt-ampere flow in the stator winding of each machine, which was developed by Consolidated Edison in 1940 and which now is used on all major generators on the system, was adopted for the Astoria machines. Figure 7 shows a simplified connection diagram of the relay system. The relay functions to trip the generator on any reduction of field current which would be sufficient to cause an amount of reactive current, equal to the relay setting, to flow into the generator, provided also that the generator terminal voltage has been reduced to a point which would indicate that the system would be better off with the generator disconnected. In case the field is weakened enough to cause out-of-step operation, the relays are adequately fast to prevent even one-half cycle of slip between the generator and the system.

The experience with this type of protection over the past 12 years has been very satisfactory. During that period there have been no incorrect operations; the relays have functioned to clear machines on field loss or reduction in 12 to 15 cases due to poor brush contact on pilot exciters, operating errors, circuit breaker latch failure, and exciter or excitation feeder short circuits. In addition, the relay acts as a backup to the normal generator protective relays and, though it never has been called upon to do so on this system, it would operate in case of out-of-step conditions in the generator, even though the field current were not reduced.



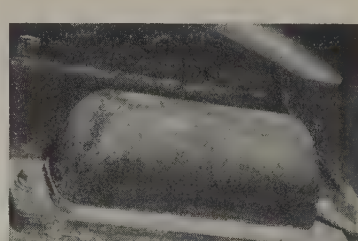



**Figure 5 (left). Vibration trip circuit. Figure 6 (right). Vibration detector**

10. *Generator Motoring.* Since motoring of the turbo-generator unit from the system is liable to cause overheating in the low-pressure turbine blades, a sensitive reverse power relay is provided in the circuit of the high-pressure generator so that when steam flow has been reduced to a point where reverse energy flows into the high-pressure generator, the machine will be disconnected from the system. The trip circuit of this relay is open while the synchronizing switch is in the synchronize position. This is done so that tripping of the generator will not occur shortly after the machine has been synchronized to the system in case power flow is reversed for a short time.

11. *Auxiliary Circuit Protection.* As shown in Figure 8, the auxiliary system is of the unit type and normally is operated with its supply coming from the generator terminals only. The primary protection consists of a partial differential which in effect operates as overcurrent protection from either or both sources of supply. In addition, instantaneous overcurrent relays are provided on each of the individual feeders which connect to the main 13-kv bus. These relays serve not only as protective devices, but also as indicating instruments to permit more rapid location of short circuits and their isolation from the remainder of the system.

Since the overcurrent protection provided on the 13-kv feeder circuit is not set sensitively enough to reach the low-voltage terminals of the auxiliary supply transformers, separate current transformers and relays are provided in the 13-kv connection to each auxiliary transformer. These relays have time selectivity with the overcurrent devices on the individual feeder circuit breakers in the low-voltage switchgear and therefore serve to provide full protection for faults within or on the terminals of the transformers and some degree of backup for the low-voltage circuit protective devices. The relays trip the main 13-kv auxiliary supply circuit breakers. This operation, of course, shuts down the entire generating unit as indicated by the over-all protection diagram of Figure 3.

12. *138-Kv Generator Feeder Protection.* The unit system of this machine, from a protection viewpoint, extends from the fuel supply to and through the first bus section to which it connects at the North Queens Transmission Substation. Accordingly, the protection of the 138-kv feeder from the generator to the substation and the substation bus are included in the over-all protection of the generating unit.

Two sets of pilot-wire relays are provided for the feeder cable. The relays are of the high-speed type operating at approximately 1 cycle for any type of cable short circuit. Either set of relays is wired to trip the 138-kv breakers at Astoria Station and North Queens Substation. Since the circuit breakers are rated 3 cycles interrupting time, it is anticipated that the total time for clearing cable short circuits will be less than 0.1 second.

The neutral of at least one 138-kv transformer of each

machine is grounded solidly. A current transformer in this circuit is connected to a relay which operates with a predetermined time delay to trip the 138-kv generator circuit breaker. The relay is not selective as to zone of protection and for this reason uses the time delay. It serves only as backup protection for transformer and cable system short circuits.

13. *Failure of Air Supply for Combustion.* Protection against the total loss of combustion air is employed to avoid the explosion hazard presented with the loss of either the forced or the induced draft fans such as would occur on the interruption of the power supply. In addition to tripping all the fuel supply to the boiler, added protection is provided for, by tripping both the turbine and the generator. Pressurized furnaces are used at the Astoria station and induced draft fans have not been installed on these boilers.

The protective arrangement in this instance is comprised of a set of auxiliary contacts on the circuit breakers of the fan motors for the trip circuit. In case of loss of voltage to a fan motor an undervoltage relay will operate, with a short time delay, to trip the motor circuit breaker.

For protection in the event of the complete closure of both the inlet and by-pass dampers of the air heaters, each damper is provided with a limit switch controlled by the damper mechanism.

Provision is made in the combustion control for automatically reducing both the generator load and the fuel input when the air supply to the boiler is insufficient to maintain a safe fuel–air ratio.

14. *Excessive Furnace and Flue Pressure.* In order to protect the furnace walls and outlet flue duct-work against excessive pressures, the forced draft fans and fuel are tripped when the pressure in the furnace reaches 30 inches of water or the pressure in the flue reaches 10 inches of water. These limits are dictated by design limitations of the Astoria station pressurized boiler furnaces and duct-work. In addition to tripping the fans and fuel, the turbine and generator also are tripped. Pressure-operated switches provide protection for the trip circuit.

15. *Complete Interruption of All Fuel.* When all fuel to the boiler is interrupted and the turbine is not tripped, boiler pressure will drop as a result of the continued demand for steam. Since a rapid drop in boiler pressure may be accompanied by a rise in drum water level, there is a possibility of sufficient carry-over to damage the turbine. Also, the sudden drop of temperature, caused by the continuing ebullition of steam without heat from combustion being supplied to the superheaters, may result in high thermal stresses and reduction of running clearances, both of which are detrimental to the turbine. To prevent the occurrence of these conditions, protection is provided to trip the turbine and the generator and sound an alarm in the event of the loss of all fuel to the boiler. It is planned to install a purging timer in the boiler starting sequence to insure that the draft fans are in service and supplying sufficient air flow for 2 minutes before any fuel can be admitted to the furnace. Furnace ignition conditions are indicated by television.

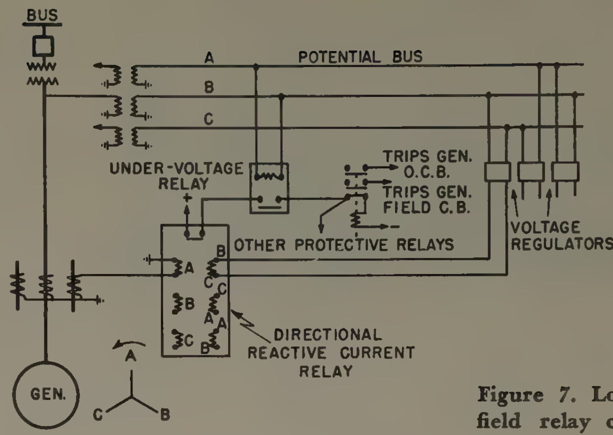



**Figure 7. Loss-of-field relay circuit**

Since these latest units are equipped to burn fuel oil, natural gas, and powdered coal, protective devices are provided for each of these fuel systems so that the boiler and turbine will be tripped out on complete loss of all fuel to the burners and are arranged as follows:

(*a*) *Fuel Oil.* The protective devices provided for this fuel system consist of pressure-operated switches in the fuel oil and atomizing steam lines. These switches are both set to trip when the pressure in either or both the fuel oil or steam line goes below a preset value which is above the pressures at which stable ignition and satisfactory atomization takes place.

(*b*) *Natural Gas.* Protection in this instance is provided against high gas pressure by pressure-operated switches to prevent loss of flame due to high burner velocity. Protection also is provided against loss of ignition due to failure of gas supply or low gas pressure by a low-pressure trip located at the burner manifold. This protection is duplicated for the separate "lighting off" gas system.

(*c*) *Pulverized Coal.* Each of the powdered-coal mills for the unit is provided with auxiliary contacts on the mill motor circuit breakers. These contacts constitute the protective device for the trip circuit.

To permit operation with intermittent firing of fuel during a boiler start-up, an interlock device is provided to make the trip circuit for the turbine and generator inoperative until the unit is synchronized and the load on

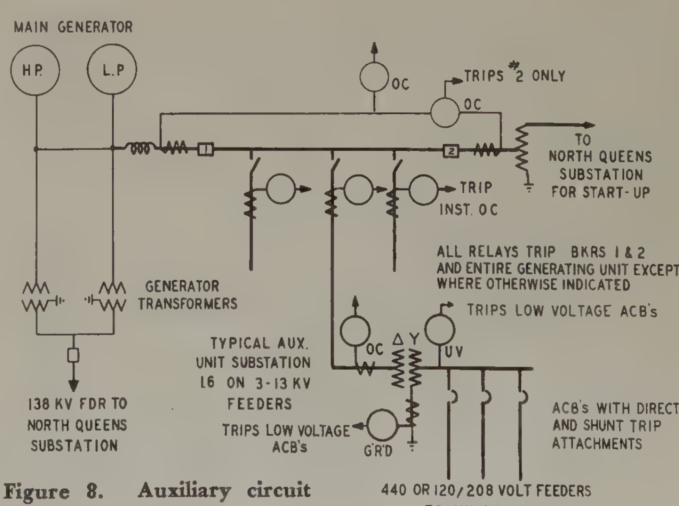



**Figure 8. Auxiliary circuit protection**

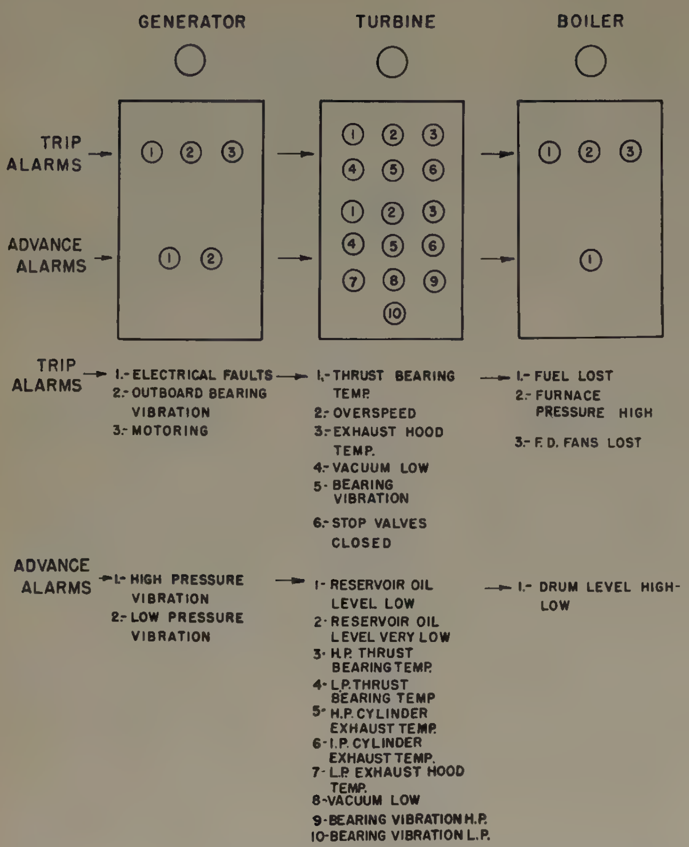



**Figure 9. Annunciator indication board: indications associated with unit protection**

it reaches 10 megawatts. The interlock used is a limit switch operated by the governor valve mechanism.

## CONTROLS, PROTECTION SIGNALS AND ALARMS

1. *Control Systems.* Following out the general plan of control which has been used at Consolidated Edison since 1946, a 125-volt d-c system is provided for control power at all points where required throughout the station area. A separate 48-volt d-c control system is provided for the controlling circuits from the control room to the equipment and for indication. This arrangement prevents the need for running relatively long control wires carrying sizable control currents at 125 volts direct current to remote locations.

2. *Protection Signals and Alarms.* Many people have inquired, on being informed of the extent of the protection provided to the units at the Astoria station and other future system extensions: "Just how are you going to determine where your trouble is in case one of the protective elements does trip out the whole unit, when a fault occurs at some point not easily and readily detectable?" It is a good question and here is the answer: The simplified diagram, Figure 9, shows an annunciator indication board which has been provided in the main control room. As will be noted, the board is intended to tell first whether the trouble is in the boiler, the turbine, or the generator part of the unit. Below these main white lights are located a number of other smaller red lamps which are arranged to indicate the general zone of the trouble, in case a tripout of the unit occurs. For instance, the first lamp below the generator indicating lamp will show when a short circuit occurs on any of the main electric portions of the unit. The second will indicate when the generator bearing vibration relay functions, and the third light of the generator group will indicate when the motoring protective relay operates. In the case of an electric fault indication, it is then necessary to go to the generator relay panel for specific target indication. Different lamps will indicate when the thrust-bearing temperature, or overspeed, or exhaust hood temperature, or low vacuum, or turbine vibration relays operate, or when the turbine stop valves become closed. In addition, another group of lights below the "Trip" indications are known as "Advance" alarms. These lights indicate when a faulty condition is developing, such as vibration in the high- or low-pressure unit, low oil level in the reservoir, or high or low water level in the boiler drum. These are aside from the alarm which will occur in case a tripout occurs.

The "Trip" indication system is so set up and interlocked that even though the tripping of one device causes the tripping of many other devices throughout the unit system, only the first tripping impulse which comes through to the control room will give an indication and retain that indication until the initiating devices are manually reset. This single indication does not, of course, apply to the various miscellaneous alarms which will come in, such as transformer fire indication, low city water pressure, loss of d-c supply at a control point, or a ground on the 48-volt d-c control system. These are each independent indications and any number of them can come up at the same time. However, each is individual and tells its own story. The alarms are grouped and identified on the different boards for the different equipment or for the different parts of the station, in a manner designed to create the least difficulty to the operating personnel.

## CONCLUSIONS

1. A protective system has been set up for the entire boiler–turbine-generator unit-type installation which will give faster response to faulty conditions and thereby lessen damage to the equipment.

2. The concept of extensive automatic tripping of large turbine-generators and boilers as reviewed in the foregoing will be received by many with a scepticism founded on the thinking that there will be frequent and unnecessary loss of capacity from systems due to malfunctioning of the automatic devices. Consolidated Edison has considered very seriously this possibility, but believes such instances, while perhaps relatively frequent in the early operating period, will be lessened with experience and resultant device improvements. The ultimate operating situation is fully expected to be one of improved availability.

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# Outdoor Power Station

E. F. DeTURK    W. J. BURNS
MEMBER AIEE

**Figure 1. Rear view of station from Hempstead Harbor**

LONG ISLAND Lighting Company placed in service in November 1952 an outdoor 90/99-megawatt turbine-generator unit at Glenwood Power Station Number 3. This is the first of three similar units which will almost double the installed capacity by the end of 1954. Two of these machines are located in a new station at Glenwood Landing on the North Shore of Long Island, see title picture, and a third in a new plant at Far Rockaway on the South Shore.

The new station incorporates the following outstanding features:

1. The turbine generator is of the outdoor type, the first to be installed in the northeastern part of the United States.
2. The turbine-generator unit is among the first 90/99-megawatt standard machines purchased and placed in service anywhere.
3. The power station is one of the few in the country designed and built with complete facilities to burn three fuels, coal, oil, and natural gas, interchangeably or simultaneously.
4. All of the instruments and controls essential to operation are contained in a central location, thereby reducing the operating force to a total of four per shift.
5. The steam generator is of the semioutdoor type with the air heaters, dust collectors, and induced draft fans outdoors.
6. Both mechanical and electrostatic dust collectors are used in series.
7. The design has minimized the requirements for antifreeze protection of air, steam, and water lines.
8. No de-aerator has been installed, removal of gases from the feedwater being accomplished in the main condenser.
9. Ample space for operation and maintenance has been provided despite the space limitation imposed by the restricted plant area.
10. The coal dust nuisance has been minimized.
11. Output from the main generator is carried by an 11-mile-long pipe-type 69-kv underground cable to a substation at approximately the load center of the system.

The station building, is a steel-framed structure with transite and brick exterior walls and reinforced concrete floors and roofs. The basic plant design has been predicated upon the unit principle with one boiler, one turbogenerator, and one step-up transformer. The steam generating unit has been designed to deliver 750,000 pounds per hour of steam continuously at 1,525 pounds per square inch gauge and 1,005 degrees Fahrenheit at the superheater outlet and 422 pounds per square inch gauge and 1,005 degrees Fahrenheit at the reheater outlet, with an 8-hour rating of 825,000 pounds per hour. The unit is of the tangentially fired tilting burner type equipped to fire high- or low-volatile coal, fuel oil, or natural gas.

The turbine is a 90/99-megawatt Preferred Standard 3,600-rpm 22-stage tandem-compound double-flow condensing unit designed for throttle steam conditions of 1,450 pounds per square inch gauge and 1,000 degrees Fahrenheit, with 1,000 degrees Fahrenheit reheat.

The hydrogen-cooled generator is rated 90/99 megawatt, 0.85 power factor, 13.8 kv, 3 phase, 60 cycle, 3,600 rpm, 0.8 short-circuit ratio at $^1/_2$-pound hydrogen, with gear-driven main exciter rated 290 kw, 250 volts, shunt wound, 1,191 rpm.

The main step-up transformer is forced-oil- and forced-air-cooling-type, rated 125,000 kva, 3 phase, 60 cycles, 13.2 to 69 kv, delta-Y solidly grounded at 69 kv. Station service power is taken from a 7,500-kva 13.2 to 2.4-kv Y-delta 3-phase 60-cycle transformer connected to the main generator leads.

The decisions to utilize a semioutdoor steam generator and outdoor boiler plant auxiliaries and to delete the turbine room enclosure have been predicated both upon economics and the preferences of the operating department. Inconveniences of operating and maintaining the facilities during limited periods of inclement weather are more than offset by the greater comfort afforded by working outdoors, unhampered by hot, confining enclosures, during most of the year. Furthermore, with system peak occurring around Christmas it is possible to schedule regular maintenance during periods of favorable weather. This arrangement coupled with the use of centralized controls makes it unnecessary for the operators to go outdoors except for routine inspections and infrequent emergency conditions.

Savings have been effected by reduced building construction and forced ventilation. Cost of weatherproofing the turbine generator and outdoor piping has been relatively minor compared with the over-all reduction in capital expenditure. It is estimated that $300,000 has been saved by the outdoor arrangement. Building volume has been reduced to the low figure of 11 cubic feet per kilowatt.

Digest of paper 53-406, "Glenwood Number 3 Outdoor Power Station," recommended by the AIEE Committee on Power Generation and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Kansas City, Mo., November 2–6, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

**E. F. DeTurk** and **W. J. Burns** are with the Long Island Lighting Company, Garden City, N. Y.

# The Delta-Grounded Transformer

E. T. B. GROSS
FELLOW AIEE

K. J. RAO
ASSOCIATE MEMBER AIEE

MANY DISTRIBUTION SYSTEMS are fed essentially from one high-voltage system through transformation. It is sometimes desirable to ground both systems at the substation which is the main source of supply to the distribution system. This grounding problem may be solved by using either a Y-Y-delta transformer with a tertiary delta winding or a conventional Y-delta bank with a separate grounding transformer. However the tertiary delta winding in the first case and the zigzag windings of the grounding transformer in the second, both remain idle under normal load conditions. In addition, a separate grounding transformer is a source of permanent no-load losses, and it requires space and extra equipment in the switchyard. The higher initial and operating costs inherent in these schemes are reduced by the use of a delta-grounded power transformer, first suggested by H. L. Hoeppner.[1]

The delta-grounded transformer, Figure 1, is a special case of a 3-phase 4-circuit transformer. The four circuits of each phase are interconnected with those of the other two phases; one (the high-voltage windings) forms a Y, another (the low-voltage windings) forms a delta, and the remaining two are connected in zigzag and so designed that they can be connected in parallel with the delta winding. For parallel connection, the delta winding must have three times the number of turns of either the "zig" or the "zag." The capacity of the high-voltage side is now equal to the combined capacity of the delta and zigzag windings in parallel. This effectively increases the capacity of the transformer bank and effects an economic gain over the scheme using a tertiary delta or a separate grounding transformer. The division of load between the delta and zigzag windings may be predicted from the positive sequence network derived for the transformer. The Y and zigzag windings of the transformer provide neutrals on its high- and low-voltage sides and both neutrals form low-impedance zero-sequence paths for neutral currents.

The transformer exhibits certain unique circuit characteristics depending on the arrangement and relative physical location of the windings. For the special (and most desirable) case in which the zig and zag windings

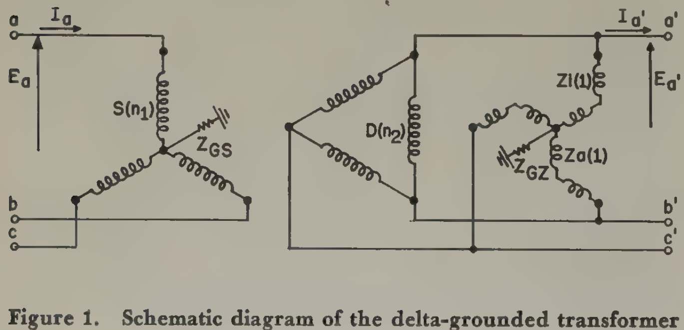


**Figure 1. Schematic diagram of the delta-grounded transformer**

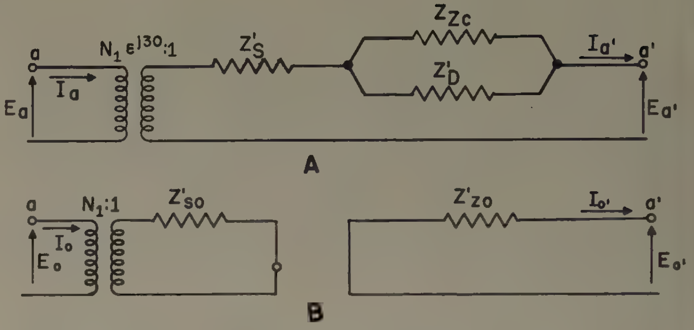


**Figure 2A (top). Sequence network for the symmetrical delta-grounded transformer, positive-sequence network. Figure 2B (bottom). Sequence networks for the symmetrical delta-grounded transformer, zero-sequence network**

are arranged symmetrically with respect to the Y and delta windings, the equivalent circuits reduce to simple circuits. The two sides of the transformer bank become independent of each other in the zero-sequence equivalent circuit. Since the zero-sequence through-impedance is now infinitely large, no transformation of zero sequence quantities from one side of the system to the other takes place. Figures 2*A* and 2*B* show the sequence networks of the delta-grounded transformer for this particular case.

To determine the characteristic components of the equivalent circuit impedances, each one may be obtained from a short-circuit test with one pair of windings at a time, the windings on only one core leg being involved. Since there are six such component impedances in the general sequence networks, this is the minimum number of tests which would be necessary. During each test all the windings that are not involved must be left open. Care must be taken to differentiate between the zig and zag windings, particularly when they are unsymmetrically arranged with respect to the Y and delta windings.

Since the first installation of a delta-grounded transformer in 1947, more than 20 have been installed on various systems. Their primary (Y) voltages range from 115 kv to 13.2 kv, their secondary voltages from 24 to 4.3 kv. All these units, mostly 3-phase transformers though single-phase units interconnected in banks may be used also, are relatively large; their ratings range from 62,500 kva to 5,000 kva.

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E. T. B. Gross is with Illinois Institute of Technology, Chicago, Ill., and K. J. Rao is with the Niagara Mohawk Power Corporation, Buffalo, N. Y.

# 170-Megacycle Radiation Survey for Bonneville System Mobile Coverage

D. E. JOHANNSON
ASSOCIATE MEMBER AIEE

D. R. WILSON

**The problems, equipment requirements, survey procedures, and record presentation involved in conducting a very-high-frequency radiation survey are presented together with the conclusions reached as a result of the project.**

THE DESIGN of a 170-megacycle very-high-frequency land-mobile communication system to provide communications over the majority of the Bonneville Power Administration's (BPA) power transmission facilities in the Pacific Northwest presented a radio survey problem of considerable magnitude. The BPA transmission system is an extensive power-line network furnishing power to load centers in Washington, Oregon, Idaho, and Montana. This system inter-ties the federal hydroelectric plants with other major public and privately owned generating plants to form the Northwest Power Pool. To operate and maintain these transmission facilities efficiently, a communication system was desired which would provide direct communications from the main power dispatchers to the mobile maintenance trucks anywhere along the 115- and 230-kv transmission lines. Since the range of a single 170-megacycle very-high-frequency radio station is limited to 20 to 40 miles, a system of land stations was required, interconnected and controlled over radio links or metallic circuits. The installation of a microwave radio system between main power generation and dispatching points has made such a mobile communications system possible.[1] The microwave system now under construction consists of a network of radio relay stations located on high hills generally following the main power transmission lines. This has provided an ideal situation where the majority of the required very-high-frequency stations could be located at the microwave stations and controlled via the microwave channels.

Since the microwave stations are located to provide the necessary line-of-sight beam paths between them, it became apparent that in many cases, due to the irregular spacing of the stations, adequate very-high-frequency coverage was not guaranteed over the desired areas. The major problem then in the development of the mobile communications system was to determine the number and location of very-high-frequency land stations required to provide adequate coverage of the BPA's power facilities.

It was determined that the most practical way to locate the very-high-frequency radio stations, so as to be assured of the required coverage, was to conduct a radiation survey of each proposed site. Initial attempts to predict the coverage that should be obtained from a given site by azimuthally plotting an optical profile proved futile, since very-high-frequency propagation will provide excellent communication into many optically shaded areas entirely by multiple reflections and diffraction. This was shown definitely by the direct comparison between an optical profile and a radiation survey conducted from the BPA microwave tower at the J. D. Ross Substation near Vancouver, Wash.

Confronted with the scope of the project, it was realized that a survey method must be developed that was both feasible from a cost standpoint yet sufficiently accurate to produce the desired data. It was estimated that nearly 50 possible very-high-frequency station sites would have to be investigated. The need, consequently, was for survey test equipment that was highly portable and yet simulated the future land station installation.

## SURVEY EQUIPMENT

THE EQUIPMENT procured for the survey consisted of three mobile very-high-frequency transmitter-receiver units (Motorola *FMTRU 80 DA 1*). The transmitters are rated at 25 watts power output and the receivers have a sensitivity rating of 0.8 microvolt for 20-decibel thermal noise quieting. Two of the mobile units were installed in sedan-delivery-type automobiles, and the other mobile unit was used for the land station. A weatherproof equipment housing was built that would allow operation in adverse weather without damaging the equipment.

When the survey was initiated in 1950, the first BPA microwave link of six stations over a distance of 180 miles just had been completed. The microwave towers are of the self-supporting type and range from 50 to 150 feet in height. The portable land station equipment was placed at the top of the towers and a 30-foot length of coaxial cable was used between the equipment and a vertical dipole-type antenna mounted above the tower structure. Later, surveys were conducted from undeveloped microwave sites, and it was necessary to provide some other means for elevating the antenna. For this purpose a 30-foot portable aluminum antenna mast was built, see Figure 1. The mast is constructed of 2-inch aluminum pipe in 6-foot sections easily carried and erected by two men. In order to provide power at the undeveloped sites a portable 1.5-kw gasoline engine generator was used, see

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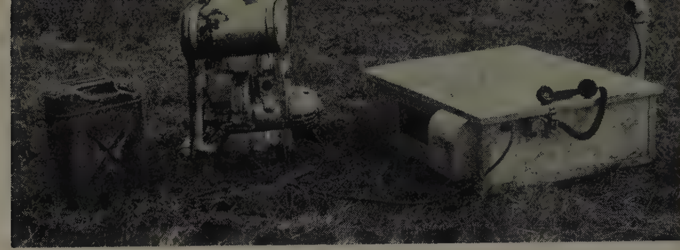
**D. E. Johannson** and **D. R. Wilson** are with the Bonneville Power Administration, Portland, Oreg.



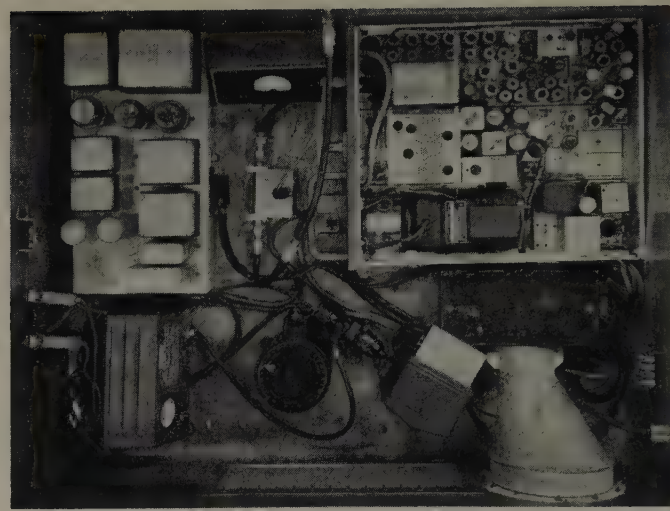


**Figure 1 (above). Portable antenna mast and test transmitter installation. Figure 2 (above right). Power plant and weatherproof equipment housing. Figure 3 (right). Detail of test transmitter and power supplies**

Figures 2 and 3. An auxiliary gasoline tank was added to enable unattended operation up to 18 hours at a time.

## PROCEDURE

There are two methods which commonly are used for the measurement of very-high-frequency signals: The first is to measure the degree of quieting of receiver thermal noise by the application of a transmitted signal. A quieting of 20 decibels has been established as that necessary for 100-per-cent communications. This method was not used since it would require intermittent keying of the land station transmitter to allow for adjustment of the decibel meter between quieting measurements. An additional disadvantage is that the quieting method does not give an accurate indication of signals above a few microvolts at the antenna terminals of the receiver. This knowledge is frequently quite important.

The second method is to measure signal strength at the input terminals of the very-high-frequency receiver. To accomplish this a logarithmic signal strength meter indication is required since the degree of change about the 1-microvolt reading should be readily discernible together with an indication of the signal level up to a maximum of 0.1 volt.

This second method was used, and a suitable signal strength meter was obtained by connecting a 0–50 microammeter through a 1-megohm resistor to the grid of the intermediate frequency amplifier immediately preceding the limiter stage in the receiver, see Figure 4. The calibration curve for this meter is a logarithmic function of signal input versus meter reading. In each of the survey cars dash-mounted meters were installed so as to be seen readily by the driver with the car in motion.

The survey procedure used required that the base station radiate continuously while the mobile operators recorded the received signal in the surrounding territory. Since the coverage from the station often would extend 20 to 40 miles in all directions, considerable time and effort could be saved by providing an automatic means for turning the transmitter on in the morning and off in the evening. Accordingly a time-clock switch was added to the base station control system.

The Pacific Northwest area has terrain ranging from mountainous, heavily forested regions to flat or gently rolling regions devoid of trees or foliage. In order to provide a simple, yet sufficiently accurate method of recording the survey data, over all types of terrain, three degrees of signal strength were established, namely:

1. "Good Communications" which was defined as an average signal strength above 1 microvolt input to the receiver.

2. "Fringe Communications," defined as a signal less than 1 microvolt average but having peaks greater than 0.8 microvolt. This level of signal and the areas in which they occurred were considered important, since a mobile operator in the area generally could maintain good communications with the land station by stopping his car and adjusting its position to a standing wave or signal peak.

3. "Insufficient Signal," defined as a signal less than "fringe," or any random signal not usable for communications.

The maps used were of a scale of 1/2 inch equals 1 mile, and these proved adequate to record the detail of signal pattern. The coverages were all obtained by driving the particular road to be surveyed and marking directly on

the map, with appropriate symbols, one of the signal categories as defined in the foregoing. In addition, the microammeter reading was marked at intervals to show the degree of signal strength.

In order to facilitate presentation, the station coverages were drawn on 30- by 40-inch sheets, and later reduced photographically to page size for presentation and record.

## EQUIPMENT MAINTENANCE

THE SURVEY CREW was equipped with a complete set of test equipment for field maintenance of the equipment. A high-quality radio-frequency signal generator with calibrated output was used to maintain a check on the sensitivity of the mobile receivers. The manufacturer's standard plug-in-type test set was used for maintenance and tuning of the transmitters. A means of accurately checking the transmitter output power was provided by two wattmeters, a Byrd Termaline and a Micromatch. The Byrd meter, which dissipates the power, was used for calibrating the load and the Micromatch, which can be inserted in series with the antenna, provided continuous monitoring of the power output. An indication of radiated power enabled accurate antenna tuning whereas a wattmeter which dissipates the power does not necessarily indicate the power radiated when the antenna is connected.

The mobile equipment used for the land station was compact, easily handled, and best suited for the physical aspects of the survey, but presented a problem due to the duty cycle rating of the final output tubes. Difficulty was experienced in maintaining proper power output and ventilation of the equipment. Most mobile equipment power amplifiers are rated intermittent commercial service (ICAS) and must be derated from the output ratings supplied by the manufacturer to permit continuous operation. The initial attempt to increase the ventilation of the power amplifier stage and to reduce the power output to 22 watts was not successful and there was frequent failure of the output tubes due to low emission. However, it was found that a further reduction to 18 watts output allowed normal tube life operating the equipment 8 hours a day.

Since the survey equipment was subjected to hard usage and frequent exposure to adverse weather, continual maintenance was required. One of the reasons that the land station equipment was built around a standard mobile unit was that one of the mobile units in the survey cars could be substituted if a failure occurred. This required operation on a 6-volt supply and increased the weight of equipment required. The dynamotors performed well under continuous service but required frequent replacement of brushes and was a source of excessive heat. Later, the substitution of a 115-volt a-c power supply in place of the 6-volt supply alleviated the ventilation problem and helped reduce total weight.

## SPECIAL SURVEYS

RECENTLY RADIATION SURVEYS have been conducted from proposed microwave sites in western Montana. Since the microwave link for this area is in the preliminary engineering stage, the sites are totally undeveloped and most of them are not accessible by automobile or jeep. Under these conditions it was physically impossible to transport the portable base station and engine-generator set into the site. Therefore an alternate survey method was used based on the theorem of reciprocity, whereby the coverage was measured by transmitting from a mobile car to a receiver at the site in place of the former method of transmitting from the site to mobile receivers.

A single mobile car was used to transmit the carrier continuously. One man, stationed at the site being tested, recorded the signal input to a calibrated receiver, which was part of a small portable battery-operated packset. In order to obtain an accurate survey, the recorded signal strength had to be closely co-ordinated with the location of the mobile transmitter. Since the portable equipment used at the site has a transmitter power of only 250 milliwatts, 2-way communications between the station and mobile was only possible over a limited area. All recorded data therefore were co-ordinated on a time basis. The man at the site recorded the signal strength, audible signal characteristics, and time, every few minutes, or more often depending on signal fluctuations. The mobile operator recorded time, car mileage, and general position. In addition, the mobile operator talked into his microphone occasionally and described his position which was recorded by the man at the site. At the end of each day's work the separate data were co-ordinated and transcribed to the map using the standard symbols.

This "receiver at the site" method has produced results equivalent to the standard survey procedure. The method is not as efficient since a man is required at the station site and only one survey car can be used. Also, the lack of 2-way communications was a hindrance in determining the outer limits of the station coverage.

## CONCLUSIONS

THE RADIATION SURVEYS, as a whole, indicate that the individual station coverages are much better than generally anticipated. However, due to the limitations of

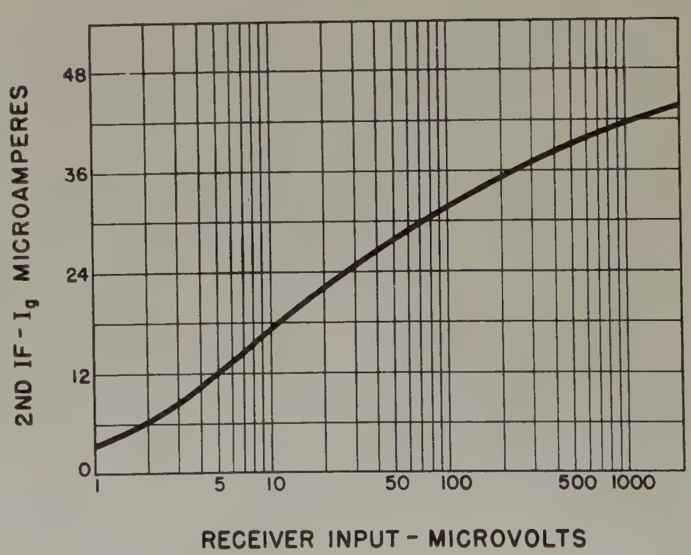



**Figure 4. Calibration curve for survey mobile receivers**


**Figure 5. A portion of the final survey record**

the survey equipment, the results obtained can be considered to be conservative, see Figure 5. The design and specifications of the permanent installations provide for land station equipment with a transmitter output of 50 watts as compared to that of approximately 18 watts for the survey transmitter. In addition the land stations will be equipped with high-gain transmitting and receiving antenna thereby increasing the effective radiated power. This should improve materially the range of the land stations. The transmitter power in the mobile units will not be increased, but the high-gain receiving antenna situated at the land stations will serve to extend the maximum range of the mobile to land station transmissions.

The data obtained from the radiation surveys have been an invaluable aid in the design of the very-high-frequency mobile radio communications system. The surveys have made possible the efficient location of the minimum number of land stations, and the permanent station coverage maps obtained will be of assistance in instructing the mobile operators in the use of the system.

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# Substations Use Aluminum Tubing as Conductor for Bus

Philadelphia Electric Company recently has placed in service three new substations using aluminum tubing as the conductor for the bus. The design of these substations features welded connections for all aluminum joints, except those at equipment terminals.

The use of welded aluminum for electrical purposes is a relatively new development in the industry and promises appreciable economies as compared with conventional bus designs using copper with bolted conductors, a company spokesman said. It is estimated that a saving of approximately 35 per cent will be realized in material and labor costs using welded aluminum in the construction of a 132-kv substation which will be erected in 1954.

The substations using the new design are the new 66-kv substation placed in service October 11, 1953, at Cromby, Pa., where the company is installing two new generators of 150,000 and 200,000 kw capacity, respectively; the new Byberry substation with two 66-kv lines and a 40,000-kva, 66- to 33-kv transformer bank, placed in service December 3, 1953; and the new North Philadelphia substation consisting of two 66-kv lines, two 40,000-kva 66- to 13.2-kv transformers, placed in service December 6, 1953.

Extensive development work has been done by Philadelphia Electric in solution of design problems and establishing construction techniques used in application of aluminum conductors. A comprehensive discussion of the problems encountered and a description of the designs used is being prepared for early publication.

# Protective Practices in High-Voltage Transmission

H. L. RORDEN
MEMBER AIEE

R. S. GENS
ASSOCIATE MEMBER AIEE

THE BONNEVILLE POWER Administration has adopted 345 kv for transmitting large blocks of power in the Pacific Northwest. The high initial investment required to transmit power at the higher voltages dictates the necessity for closely engineered practices. Revisions in practices that have resulted in lower costs for the 230-kv grid will be adopted for the 345-kv circuits and include: (1) reduced insulation levels, (2) high-speed automatic switching, (3) reduced lightning arrester levels, (4) elimination of provision for continuous overhead ground wire, (5) use of large single-phase autotransformer banks, and (6) elimination of spare single-phase transformers.

The major 230-kv grid of the Bonneville System, which is not equipped with continuous ground wire, has been operated for several years with high-speed automatic-reclosing line-circuit breakers instead. Success of automatic switching as a means of lightning protection has made it feasible to use lighter weight steel towers, incapable of supporting ground wires, thus effecting considerable savings. The system has grown to the extent that it can withstand momentary interruption of any two 230-kv lines, and sustained outage of any one circuit without becoming unstable, so that with automatic switching the simultaneous momentary interruption of both circuits on double-circuit lines is not serious.

With 1 mile of ground wire for protection of station equipment, the number of lines terminating on a station bus is a major factor in limiting the potential of traveling surges that can reach station busses. In most Bonneville stations surges of high enough magnitude to cause arresters to operate are not anticipated. The magnitude of traveling waves at station busses may be determined by a simple graphic method of solution, whereby necessity for lightning arresters can be determined.

The unbalance that occurs due to faults does not result in voltages high enough to be dangerous to insulation, but they may be dangerous to lightning arresters. To increase arrester ratings in order to protect them may require higher basic impulse insulation levels (BIL). This practice requires considerable expenditure to protect the protective device.

Where insulation levels are closely engineered, the $10 \times 20$-wave lightning-arrester current test is not realistic enough as a criterion for selecting BILs based on a $1^1/_2 \times 40$-wave test and well may result in a false sense of security. In present Bonneville practice for selecting BILs, 20,000-ampere average $10 \times 20$-wave station-type arrester protective levels are used as indicative of 5,000-ampere levels for the steeper wavefronts expected, including arrester tolerances. While oscillatory voltages may occur if arresters are placed some distance from the protected equipment, such as circuit breakers, additional protection is not ordinarily needed.

**Figure 1. (Top) 75,000/100,000-kva 220–110-kv 1,050–550-kv-BIL 2-winding transformer bank (1940). (Bottom) 150,000/-250,000-kva 230/-115-kv 825–450-kv-BIL autotransformer bank (1952)**

The recent advent of arresters having lower protective levels for higher surge currents suggests the possibility of using parallel arresters for direct-stroke protection. Lower protective levels also may lead to lower line and station insulation levels.

Insulation levels for 230 kv have been reduced from 1,050 to 825 kv, resulting in a 20-per-cent reduction in transformer costs. Figure 1 illustrates the relative size of banks installed in 1940 and in 1952.

The 345-kv circuits will be an integral part of the 230-kv grid, using identical autotransformers at both ends of the lines for stepping up from 230 to 345 kv and down again. All switching will be at 230 kv, so that the autotransformers become an integral part of the transmission line. Station equipment will be protected with a mile of ground wire, but otherwise transmission structures will be incapable of supporting ground wires. The 230- and 345-kv terminals will be protected with 182- and 265-kv lightning arresters, respectively, for transformer BILs of 825 and 1,175 kv. In invitations to bid on the first two banks of autotransformers, two manufacturers offered alternate quotations for 1,175/-825-kv and 1,300/900-kv BILs. The lower BIL was accepted without a spare. The difference in cost between the lower and higher BIL was more than the cost of a spare transformer.

Digest of paper **54-19**, "Protective Practices as a Criterion for High-Voltage Transmission Design," recommended by the AIEE Committee on Transmission and Distribution and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 18–22, 1954. Scheduled for publication in AIEE *Transactions*, volume 73, 1954.

**H. L. Rorden** and **R. S. Gens** are with the Bonneville Power Administration, Portland, Oreg.

# Dynamic Braking of Squirrel-Cage Induction Motors

C. F. EVERT, JR.
ASSOCIATE MEMBER AIEE

THE APPLICATION OF direct current to the stator of a 3-phase induction motor long has been recognized as a means of producing a retarding torque on the moving rotor. Methods have been given for evaluating the average braking torque, but a simple means for determining the complete speed torque curve during braking will be of value for the control engineer.

Direct current flowing in the stator of an induction motor will produce stationary magnetic poles around the stator periphery. If the rotor is turning, the rotor bars cut the magnetic flux at a rate depending upon the speed of the rotor. Hence a voltage is produced in the rotor, and the resulting rotor current acting with the flux produces a retarding torque on the machine.

Since the rotor current is alternating, the usual equivalent circuit of an induction motor may be utilized for purposes of computation provided slip ($s'$) is defined as $s'=N/N_s$ where $N$ is the actual rotor speed and $N_s$ is the synchronous motor speed. In practice the normal equivalent circuit may be simplified to be only two parallel circuits—one of value $X_m$, the other of $R_2/s'$, where $X_m$ is the per phase magnetizing reactance and $R_2$ the per phase rotor resistance both referred to the stator. Both values may be determined by the usual short-circuit and no-load tests.

If the direct current is supplied to a Y-connected stator via two of the three terminals, the a-c equivalent of the stator direct current is $I_1=0.815I_{dc}$. Also $I_1=I_2+I_m$ where $I_2$ is the alternating current per phase rotor current in stator terms and $I_m$ is the a-c magnetizing current per phase in stator terms. $I_1$ is the vector sum of $I_2$ and $I_m$ which are in quadrature. See Figure 1.

The magnetizing current in the normal equivalent circuit of an induction motor is nearly constant. During dynamic braking the a-c equivalent stator current is a constant, and since the rotor current depends upon speed, both the rotor current and magnetizing current must change as the slip changes. Due to this dependence of the magnetizing current upon slip, the flux and rotor induced voltage also are variables.

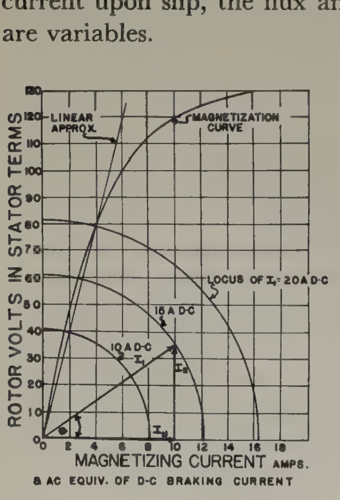


**Figure 1. Magnetization curve for induction motor and linear approximation for curve with the vector diagram for the currents superimposed**

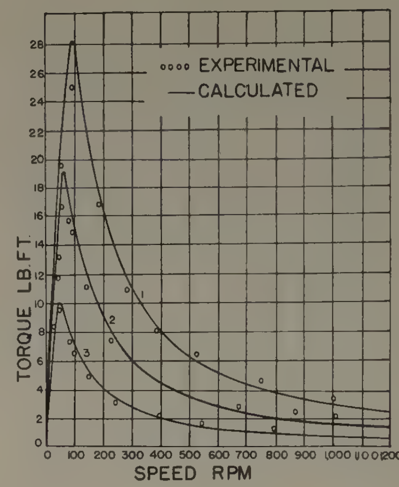


**Figure 2. Dynamic braking speed — torque curves for 5-horsepower 1,120-rpm induction motor. Curve 1–20a d-c; Curve 2–15a d-c; Curve 3–10a d-c; Stator connection 2 phases in series. A calibrated d-c motor was used to determine experimental points**

The rotor-induced voltage per phase in stator terms ($E$) may be determined from a magnetization curve for the machine. The magnetization curve is obtained by driving the induction motor at synchronous speed while the applied 3-phase alternating voltage is varied from zero to over rated value. Power, current, and voltage are read at each point. The per-phase rotor voltage in stator terms is equal to the applied voltage per phase minus the stator impedance drop. The magnetizing current is equal to the a-c stator current since the rotor is open-circuited at synchronous speed.

With $I_1$ known, a value of $I_2$ is chosen and $I_m$ evaluated. The corresponding value of $E$ can be read from the magnetization curve. Then: torque$=(3\times 7.04/N_s)EI_2$ foot-pounds; speed$=(I_2R_2/E)N_s$ revolutions per minute. The torque so computed is based on synchronous watts, thus the actual braking torque will be somewhat higher due to the friction and windage retarding torques.

In the region of the magnetization curve which is approximately linear the following equations are useful: speed$=(N_sR_2/m)\tan\theta$ revolutions per minute; torque$=(KmI_1^2/2)\sin 2\theta$ foot-pounds. Where $m$=slope of magnetization curve, $\theta$=angle between $I_1$ and $I_m$, and $K=7.04\times 3/N_s$.

The method is rapid and simple, requiring only conventional tests. At currents in excess of rated values the peak torque will be in error, but the peak torque contributes little to the average braking effect.

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Digest of paper 54-3, "Dynamic Braking of Squirrel-Cage Induction Motors," recommended by the AIEE Committee on Rotating Machinery and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 18–22, 1954. Scheduled for publication in AIEE *Transactions*, volume 73, 1954.

C. F. Evert, Jr., is with the University of Cincinnati, Cincinnati, Ohio.

# Type N Carrier Telephone Deviation Regulator

E. H. PERKINS J. J. MAHONEY

THE TYPE *N* system, introduced into the field some 3 years ago for short-haul toll telephone service, provides flat regulation for the group of 12 channels at each repeater and the receiving terminal, and individual channel regulation at the terminal only. Up to about 150 miles this regulation has been ample. Although the flat regulation is adequate beyond that length, the transmission variations caused by temperature changes may exceed the regulating ability of the individual channels. To prevent this condition a deviation regulator has been designed for insertion into the high-frequency line at appropriate intervals. Systems long enough to require a regulator have certain transmission advantages when using a recently developed channel 13 so that the regulator is activated by the 12 channel carriers, 2 to 13. The regulator determines the departures for each channel carrier from its nominal, and regulates the line transmission by networks so as to produce a minimum residual. The regulator is shown schematically in Figure 1. It connects to the output of a low-high repeater, and consists of four main blocks as indicated by the dotted lines: the thermistor controlled shaping networks, the regulator amplifier, the channel filter bank, and the computer and four control circuits.

The shaping networks are each separate units and vary from an extreme shape through a mean condition having flat shape to an extreme inverse shape. The shapes are chosen to match system changes encountered and are called slope, bulge, cubic, and quartic. Flat regulation is provided by the preceding repeater. The regulator provides ±10 decibels of slope correction and ±5 decibels of the other three shapes. As these networks all act independently, they all can have a similar time constant without risking unstable transient response.

The line amplifier compensates for the 60-decibel loss of the networks. The signals used for control are derived from a pick-off amplifier, and separated by the 12 channel filters. The filter outputs are adjusted so that they are a replica of those transmitted from the line amplifier. The filter outputs drive the computer circuit and the four control circuits so as to provide the necessary regulating thermistor current to the four networks.

The regulator uses type *N* and type *O* structures throughout. The components using vacuum tubes; that is, the regulator amplifier and the four control units, are all plug-in units with die-cast frameworks and miniature parts. They are readily changed and provide good accessibility for inspection or repair.

Digest of paper 53-334, "Type *N* Carrier Telephone Deviation Regulator," recommended by the AIEE Committee on Wire Communications Systems and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Pacific General Meeting, Vancouver, British Columbia, Canada, September 1–4, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

**E. H. Perkins** is with Bell Telephone Laboratories, Inc., Murray Hill, N. J., and **J. J. Mahoney** is with Bell Telephone Laboratories, Inc., New York, N. Y.

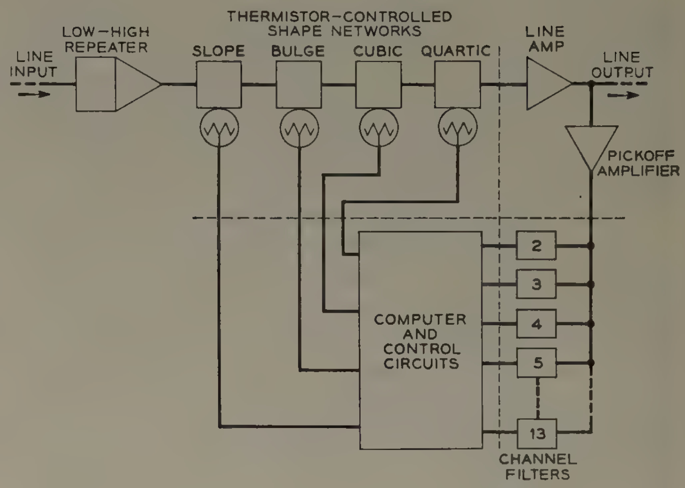


**Figure 1. Regulator block schematic, showing by dotted lines the four basic circuit blocks of shaping networks, regulator amplifier, channel filters, and computer and control circuits**

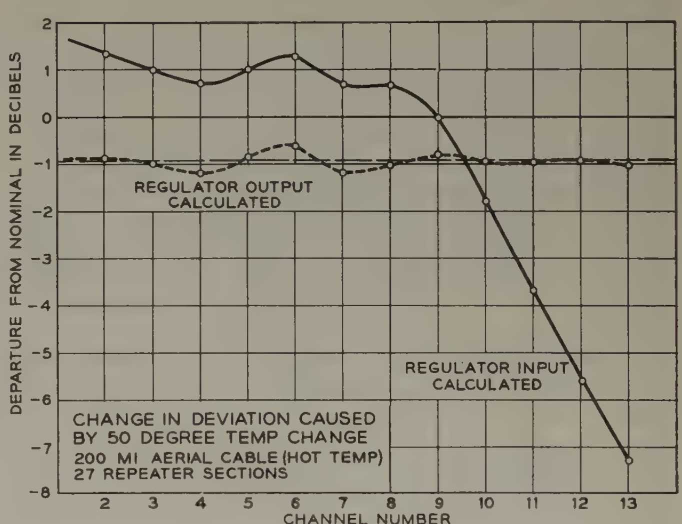


**Figure 2. Regulator correction for 200-mile aerial cable system at hot temperatures**

Extensive tests and calculations of the regulator performance with the types of system variations expected have been made. A typical example of the correcting ability is shown in Figure 2 for a 200-mile aerial cable system operated at 50 degrees Fahrenheit above its line-up temperature. The plot shows the input and output characteristics. Similar performance has been determined for lowered system temperatures and also for buried cable where the repeaters produce most of the transmission change. These tests indicate that the regulators can be used at intervals along a line to remove temperature swing as the controlling factor in limiting the length of the system.

# Boolean Algebra in Electronic Circuit Design

S. H. WASHBURN
ASSOCIATE MEMBER AIEE

BOOLEAN ALGEBRA may be utilized in the design of electronic switching circuits by a method analogous to that applicable to the synthesis of relay switching circuits. This method involves the interconnection of idealized 2-valued elements to form circuit arrangements fulfilling the original design requirements.

The operating requirements for a combinational switching circuit usually are expressed in terms of the states of the output leads as functions of the states of the input leads. In most electronic switching circuits, a given lead is in one of two voltage states, the states differing in magnitude or sign of the potential. The behavior of an output lead as a function of the states of the input leads may be indicated by a Boolean expression in which the variables are the input leads. The value of each variable is either 1 or 0, depending upon whether it is energized or deenergized, respectively; the operations of addition and multiplication correspond, respectively, to the logical connectives "or" and "and."

The building blocks of an electronic combinational circuit are gate elements. There are six operationally unique 2-input gates, although each may be represented by two different, but equivalent, algebraic expressions. These gates are shown in block form in Figure 1, together with an inverter element. The behavior of each gate is indicated symbolically, and corresponds to the Boolean expression shown in the figure below the gate. The "+" and "−" potential symbols are used to specify the operation of the gates. For example, in the gate characterized by the expression $AB'=C$, the lead $C$ has a "+" potential when and only when, lead $A$ has a "+" potential *and* lead $B$ has a "−" potential.

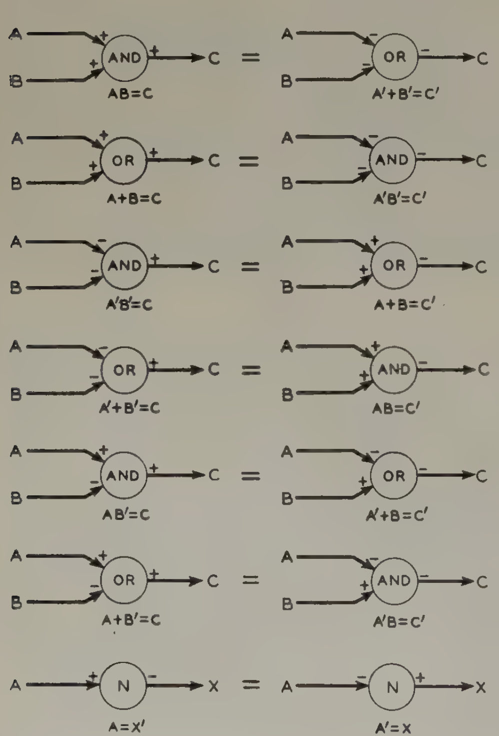


**Figure 1. Table of gate elements for switching circuit application**

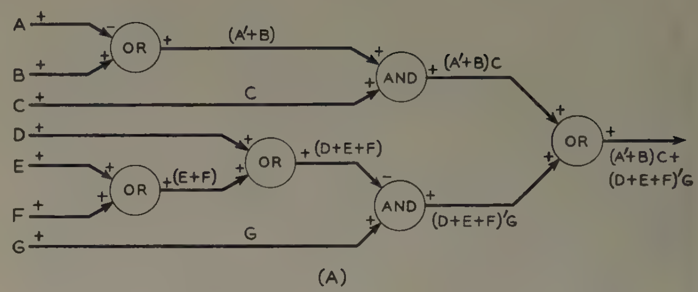


**Figure 2. Typical switching network configuration**

To construct an electronic circuit which is equivalent to an algebraic expression, it is only necessary to select and connect gate elements as specified by the expression. The expression is separated into two functions related by either multiplication or addition. This determines whether the gate whose output lead is the output lead for the circuit is to be of the "and" or the "or" type. The two functions into which the original expression is separated form the input to the gate. Where a function is expressed as the negative of another function, a gate with a "−" associated with the input lead corresponding to this function is used; otherwise a "+" is associated with the input lead. Every gate output is labelled "+."

The two functions then are separated to determine the nature of the gates feeding the output gate. The process is continued until only single variables remain. These represent input leads to which the signals controlling the circuit are applied. This process is carried out in Figure 2 for the algebraic expression $(A'+B)C+(D+E+F)'G$.

Alternative circuit forms may be obtained either by manipulation of the algebraic expression or by direct operation on the gate configuration following certain rules. Such alternative forms may be more desirable than the original in terms of number of components, choice of gate types, or operating margins.

Electronic circuits involving memory, or storage, also can be designed by these techniques. Here, it is necessary to specify the memory capacity and the sequential order in which the memory elements must function. Once this has been done, the remainder of the problem is that of synthesizing gate configurations for the control of the memory elements and for the association of memory element outputs and the circuit output leads.

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Digest of paper 53-216, "An Application of Boolean Algebra to the Design of Electronic Switching Circuits," recommended by the AIEE Committee on Communication Switching Systems and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer General Meeting, Atlantic City, N. J., June 15–19, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

S. H. Washburn is with Bell Telephone Laboratories, Inc., New York, N. Y.

# American and European Circuit Breaker Rating

R. C. VAN SICKLE
FELLOW AIEE

THE DIFFICULTY in comparing the ratings of European and American power circuit breakers results from differences in the methods of stating the interrupting rating. The rms value of a short-circuit current usually varies with time. Its maximum value occurs at the initiation of an asymmetrical short circuit and is the value of current which must be closed or carried by the breaker. The currents to be interrupted include those which are initially asymmetrical and which at contact parting still may have appreciable asymmetry. Consequently the ratings must state the ability of the breakers to close or carry and to interrupt both symmetrical and asymmetrical currents.

A European power circuit breaker is given a rated making current and two interrupting ratings, one for symmetrical currents only and one, usually about 25 per cent larger, for asymmetrical currents only. The rated making current equals an asymmetrical current having an a-c component equal to the rated symmetrical interrupting current offset by the maximum probable d-c component.

This making current limits the application of the breaker to circuits in which the a-c component does not exceed the rated symmetrical interrupting current. Consequently, the rated symmetrical interrupting current can be interrupted only when there is no decrement in the a-c component during the short circuit. The rated asymmetrical interrupting current can be interrupted only when the rms value of the asymmetrical current at the time of contact separation exceeds the rms value of the initial a-c component by the amount that the rated asymmetrical current exceeds the rated symmetrical current. This requires the relays and breaker to separate the breaker contacts about 2 cycles after the short circuit starts. Consequently, in most cases this higher value of asymmetrical interrupting capacity cannot be used.

In contrast, an American power circuit breaker is given a rated making current and a single rated interrupting current at rated voltage which applies to both symmetrical and asymmetrical currents and which is numerically the same as the rated symmetrical current of a corresponding European breaker. It has in addition a supplementary rating for specifying its use on other service voltages, the maximum interrupting current at reduced voltage.

Some authors familiar with the other method of rating breakers have attempted to discount American interrupting ratings by stating the ratings are only for the interruption of currents with large asymmetry at the time the contacts part and they then have reduced the interrupting rating by applying their ratios between asymmetrical and symmetrical interrupting ratings. They have ignored the two sections of the American standards which cover these points.

The definition of the interrupting rating American Standards Association (ASA) *C-37.4-6.11* specifies the total rms interrupting current with no reference to the amount of asymmetry. Consequently, the breaker may be applied up to its rated current either where no asymmetry can exist at the time of contact parting or where asymmetry may still exist at contact parting.

The second reference is in ASA *C-37.9-1.25* which states:

> SYMMETRICAL AND ASYMMETRICAL. Since both displaced and symmetrical current waves occur in practice, circuit breakers should be capable of handling their maximum short-circuit current ratings with either type of wave. Laboratory testing practice is to use both symmetrical and asymmetrical currents.

The 1953 revision out for approval at the time this is written has modified the test code and section *9-2, 6, 2, 1* includes the following statement:

> ...A sufficient number of circuit opening tests shall be made between load current and full-rated short-circuit current to assure successful interruption of symmetrical and asymmetrical currents over the entire short-circuit current range....

Comparisons of European breakers with American breakers based on a derating of the American breaker for symmetrical currents are false.

In American practice the rated making current is 1.6 times the maximum interrupting current at reduced voltage. This is adequate to permit the breaker to be used up to its rated interrupting capacity at rated voltage and lower service voltages. The factor of 1.6 is based on American application practice and allows for loaded conditions on the system which can increase the initial a-c component. If a European breaker is applied by our practice, the making current becomes a limitation and the maximum symmetrical interrupting current for which the European breaker can be used is about 94 per cent of its rating.

In brief, the European breaker is assigned two interrupting ratings, one for symmetrical currents and one for asymmetrical currents, but the rated making current limits their usefulness.

The American breaker is assigned a rated interrupting current at rated voltage and a maximum interrupting current for lower service voltages. These values apply for the interruption of either symmetrical or asymmetrical currents. The rated making current which corresponds to the maximum interrupting current is adequate for the corresponding interrupting duty at any permissible service voltage.

Digest of paper 53-346, "Is the European Circuit Breaker Rating System Really More Conservative Than the American?," recommended by the AIEE Committee on Switchgear and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Pacific General Meeting, Vancouver, British Columbia, Canada, September 1–4, 1953. Scheduled for publication in AIEE *Transactions*, volume 72, 1953.

R. C. Van Sickle is with Westinghouse Electric Corporation, East Pittsburgh, Pa.

# How Should a Manager Spend His Time?

P. F. DRUCKER

**Of all man's resources, time is the most perishable. The manager who knows how to spend his time is likely to manage well, for how he utilizes his other resources depends to a very large extent on how he utilizes his time. Four basic rules are discussed.**

In the course of a fairly long career as a management consultant, I have seen both managers who knew how to spend their time and managers who wasted it, managers who had very high efficiency and productivity in handling this most perishable of all resources, and managers who frittered it away, invested it wastefully, and let it run through their hands. And because I am rather envious of those managers who do a good job managing their time I have been watching them fairly closely in the so-far forlorn hope that I too might learn how to do a better job at managing my own time.

The managers who know how to make time do their bidding, the managers who get the most out of time, do not fall into one type and do not fall into any one pattern. And in nothing are they more different than in their attitudes towards time. Some of them only can be called "time-misers"; others are prodigal with time and treat this scarce commodity as if it were in abundant supply—and yet they seem always to have more of it. Some schedule their time to the point of being pedantic. I know one man for instance, the financial vice-president of a large company and one of the most efficient men in utilizing his time I ever have seen, who sets aside religiously 45 minutes the first and third Monday of each month to get his hair cuts. In the months in which there are five Mondays he instructs his barber to cut his hair shorter rather than change his schedule. I know other people, equally efficient in using their time, who seem to have been born without any time sense whatsoever. They may work 3 hours one day and 19 hours the next, be infinitely flexible in their schedule, if indeed they can be said to have one, and yet never seem to waste any time.

Though they differ greatly, all these men seem to have in common a refusal to use any mechanical device, any panacea, any "right method." They do not for instance believe that one saves time by learning how to read fast. They know better. They know that reading speed has to be adapted to what one reads and that the fellow who only can read fast is just as unable to read well as the fellow who only can read slowly. They do not, to a man, believe that all reports should be summarized on one or two pages. On the contrary, I suspect that they would feel that a report that lends itself to such a summary is a report that never should come to their attention because it is not really important enough to deserve the time and attention of busy, important, and effective people. The kind of matter on which they feel that they themselves should spend time is likely to be such as to require their intensive study, their serious consideration, and their careful reading of all the evidence—no matter whether it runs to 2 pages or to 200. But these people also do not believe in any mechanical rule such as that no interview should last more than 10 minutes. They are quite capable of cutting down interviews that are not important to 1 minute. On the other hand, I have known them to spend whole days with one man when either the man or his concern warranted it.

### FOUR BASIC RULES

In other words I have no easy solution to report, no ready-made formula. But I can report that these men, however different in temperament, ability, and approach they are otherwise, invariably observe four basic rules. I also have noticed that those managers whose management of their time leaves a great deal to be desired invariably break these four rules. These rules unfortunately are not things you simply can take and apply when you go to your own work tomorrow. They do not tell you how much time you should spend. They only tell you on what things you should try to spend more time and on what things you should try to spend less time.

### SYSTEMATIC PLANNING

In the first place I have noticed that the people who get the most done spend the least time on doing things. They are great "doers" as far as achievement is concerned; but they do not get their achievement by spending time on doing things. They get it by spending time on planning things. They are, as far as I can tell, perfectly willing to spend any amount of time on thinking before they act—and practically no time on acting after they have thought. They set objectives first—and spend a great deal of time not only on setting these objectives but on thinking through what the areas are in which objectives should be set. They are pretty clear in their minds what the third step is going to be before they take the first one. I realize that this is dangerous counsel. Very often worrying too far ahead means inaction. But somehow these people

Essentially full text of a conference paper presented at the AIEE Fall General Meeting, Kansas City, Mo., November 2–6, 1953, and recommended for publication by the AIEE Committee on Management.

**P. F. Drucker** is a management consultant, Montclair, N. J.

who manage to use their time well avoid inaction and yet think and plan ahead. In particular they are willing to spend a very great deal of time on thinking through systematically action that is constantly recurrent. Most managers, for instance, spend a very large amount of time, in small driblets, on the attempt to appraise the men who work under them and their performance. These men do not. Instead they insist on systematic appraisal of their men once a year or so that they, as the result of a few hours' work, have the answers for all the decisions—on a man's salary, on his promotion, on his work assignment for instance—on which judgment of a man's performance and potential is required. Similarly they do not, like many managers I know, spend a great deal of time on doing modification engineering on their products. They sit down once a year for a few days perhaps and work out with their Sales Department and their Manufacturing Department the basic policy, the objectives, and the rules for modification engineering, determine how much of it there should be, and assign the needed engineering manpower in advance to the job. In their eyes it is no praise to say: "This year we managed to get through this inventory crisis, thanks to the experience we had acquired last year." If you have a recurrent crisis you spend the time to find out what causes it and prevent it. This may take time but in the long run it is bound to save a great deal more time.

## COMMUNICATIONS

PERHAPS THE greatest difference between the managers I know who know how to use time and those I know who do not, is in the time proportions they give to their communications. In my experience the managers who know how to use their time have, on the whole, amazingly good communications with their subordinates, their associates, and their superiors. But they seem to be spending absolutely no time on communications "down," on communications from them to their subordinates. They do not seem to need to. Perhaps the reason for this is that they spend a very considerable amount of time on communications "up." Apparently these men not only know what all of us know, but unlike the rest they act on the knowledge; that the real problems of a manager are not his communications down but his communications up. At least I know no president of any company who does not consider his relations with his Board of Directors more difficult and more critical than his relations with his vice-presidents, no vice-president who does not consider his relations with the president more critical and more difficult than the relations with his section heads, and so forth down to the production foreman who, in my experience, practically always is convinced that he could manage relations with his men all right if only the plant manager and the Personnel Department let him alone. I know this is heresy. We have been propagandized on "communications to the worker" till we all are overflowing with employee magazines, letters from the president, and other attempts to get the good word down—attempts which, I am afraid, are not very effective and are incredibly time-consuming. Instead, the managers who manage their time well, according to my observation spend a very great deal of time on communications up. As far as relations with their subordinates are concerned this means that they do not talk to their subordinates about their own problems but somehow get their subordinates to talk to them about the subordinates' problems. Instead of talking they listen—and what may be more important, they know how to make the subordinates talk. One man I know who is most efficient in the utilization of his time is quite willing to spend a very great deal of time—and to have his subordinates spend a great deal of their time—on a quarterly "Manager Letter" which he requires of every subordinate. In this the subordinate sets down in great detail what he considers the objectives of his job to be, what his plans are, what his superior (the manager to whom this letter goes) contributes to the success of the subordinate's activity and what he does to hamper the subordinate, and finally, what the subordinate plans to do to attain his objectives. This particular manager spends several hours every 3 months with each of his 12 or 14 men going carefully over the "Manager Letter." As a result I do not think he has to worry much about his communications down to them or has to spend much time.

As far as communications up from the manager to his own superior are concerned, this concern with upwards communications, this willingness to spend a good deal of time on it, means that the manager who utilizes his time well spends a great deal of time on considering his boss's problems, a great deal of time worrying what he can do to contribute to the success of his boss and to the success of the whole activity and of the business. He takes responsibility, in other words, for his boss's job; he considers this part of his own job as a manager. He is quite willing to invest a good deal of time into it. As a result he seems to need no time on "communications" with the boss, no time for clearing up the messes that result from a confusion of objectives and a confusion of viewpoints.

## DEFINING THE PROBLEM

YOU HEAR A great deal these days about "problem solving." However, the managers who utilize their time well seem to spend no time, or very little time, on finding the answer to a problem. Instead they are willing to spend a great deal of time on trying to find out what the problem is and on defining it. In their experience—let me repeat, I just report what I have observed—answers are neither difficult nor important. What matters is that you have the right problem. The answer usually will produce itself; and it certainly will be the answer to the right problem. There is nothing quite as useless as the right answer to the wrong problem. In trying to define what the problem is these managers who use their time well rely on strict methods rather than on hunches, and spend a very great deal of time to develop methods of analysis of a problem.

## BUILDING SALES APPEAL INTO THE PRODUCT

FINALLY, THESE managers spend no time on "selling" the results of their thought and work. Where all the rest of us waste a tremendous amount of time on thinking

about the "presentation" of our ideas and recommendations, these people just do not sell at all. Somehow they succeed in building the sales appeal into the product rather than having to spend time and energy afterwards on beating the bushes to find a customer or beating him over the head to get him to buy the product. They do this by spending more time—during the development of the idea, the thought, or the recommendation on getting the acceptance of the people who will have to work and live with the new idea, the new design, or the new policy. They do not ever bring anybody into their thinking until they themselves have worked out to their own satisfaction what the problem really is; until they have defined the problem. Then they bring in these other people, whether they are their superiors, their subordinates, or their associates in some other activity: the manufacturing people who have to produce the design, the sales people who have to sell it, the financial people who have to approve of the expense. They bring these people in before they themselves have worked out the solution. I am fairly certain that they have a shrewd idea what kind of a solution, design, or policy they would like to come up with. Somehow, by the very fact that they have defined the problem first, they manage to maintain control over the outcome. But as far as possible they let these other people work through to the solution. They let the solution become "their" solution, to the point where any selling that has to be done usually is done by these people themselves. While such managers are totally unwilling to spend any time on selling, they are willing to spend tremendous amounts of time on building the sales appeal into the product by bringing in the people whose solution it has to be as active participants in the working out of the solution or the program. On balance, however, I am convinced they are far ahead—and not only in respect to the saving in time.

### SELF TESTS

These are the four rules I have observed. To them I would like to add one trick, one way I have seen used successfully in which a manager can improve his utilization of his time. He cannot do so by any mechanical rule such as a set reading speed, a predetermined length for reports, or a fixed time limit for interviews. He can improve his performance if he is willing to test himself as to whether he observes the four rules I have reported: spend all the the time you can on planning and as little as possible on "doing"; spend all the time you can on communications up—both up to you and up from you—and as little time on communications down; spend all the time you can on defining what the problem is and as little time as possible on finding an answer to it; and, finally, spend all the time you can on building sales appeal into the product and as little as possible on selling it. The way to do this is for you to ask your secretary to keep a diary of the way you spend your time for the next 4 weeks. Ask her to put down everything you do, every telephone call, every letter, every conference, every coffee break. Do not peek over her shoulder during those 4 weeks—though I admit it is not easy to restrain one's self. At the end of 4 weeks take the diary. It will make very amazing reading to you, I can assure you. And at least in a few cases this admittedly harsh, radical, and most unpalatable medicine has had amazing results in making people stop the worst of their time-wasting habits, in making them shift the emphasis in their expenditure of time to the profitable, the productive phase of their work rather than on cleaning up messes and bolstering weak spots—all extremely time-consuming and all avoidable by proper expenditure of the time on avoiding confusion, building on strength rather than on weakness.

In my experience a manager who knows how to spend his time is likely to manage well and a manager who does not know how to use his time is unlikely to manage well; in other words, managing well and utilizing one's time well very well may be pretty much one and the same thing. A manager has basically only two resources: people and time. How he utilizes his human resources depends, I am quite convinced, to a very large extent on how he utilizes his time. For of all the resources at the command of man time is the most perishable, the one that once spent never can be recovered again.

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# Merchant Ships Protected From Corrosion by Cathodic Process

**Rockland Light and Power Company, Nyack, N. Y., is supplying electric service to provide corrosion protection to about 150 merchant ships of the National Defense Reserve Fleet anchored in the Hudson River off Jones Point, N. Y. The vessels are continuously inspected and preserved above the water line by special crews of the Maritime Administration. This agency also provides underwater protection against corrosion through cathodic application of 24-volt direct current to the ships' bottoms. This cathodic process is not harmful to human or marine life and insures underwater protection. Small graphite electrodes have been laid on the river bottom beneath each ship and are connected electrically to rectifiers set up on the decks of selected vessels. A-c power to operate the rectifiers must be brought via submarine cable from the shore. Four substations totaling 200 kva have been completed by the power company to supply all a-c power requirements for cathodic protection, lighting, and small power through submarine cable to the ships**

# Exhibits, Papers on Information Processing Featured at Eastern Computer Conference

The Eastern Joint Computer Conference, which was held in the Statler Hotel, Washington, D. C., December 8–10, 1953, had as its theme, "Information Processing Systems—Reliability and Requirements." More than 1,000 engineers attended the six technical sessions and visited the elaborate exhibits of nearly 40 manufacturers displayed in three rooms adjacent to the ballroom. Seven inspection trips to nearby Government bureaus and laboratories were made where computers are functioning. On Tuesday evening, a reception and cocktail party was held for all registrants and their guests in the Presidential Room of the headquarters hotel. In addition to the AIEE, the sponsors were the Institute of Radio Engineers (IRE) and the Association for Computing Machinery.

The address of welcome was made by J. H. Howard, chairman of the IRE Professional Group, Electronic Computers, at the opening session, over which F. J. Maginniss, secretary of the AIEE Committee on Computing Devices, presided. H. T. Engstrom, Remington Rand, Inc., in the keynote address, gave a short history of computers prior to the war and told how they had advanced in every way since 1945. He outlined the scope of the conference program which would follow.

### APPLICATIONS

In his report concerning the support given past computer conferences by the Radio-Electronics-Television Manufacturers Association (RETMA), T. H. Briggs, Burroughs Corporation, reviewed the conference on tubes used in computers and told how greatly computers in general had benefited because of the better tubes which are now available. He related how questionnaires concerning tubes had been sent to all interested parties and how the excellent results obtained from them had assisted everyone. Other RETMA committees have been formed to study other components.

A paper by M. E. Davis of the Metropolitan Life Insurance Company was read concerning the problems involved in adapting insurance records as they now are to a form which would be suitable to be fed into computers.

The last paper of the session, "Computer Applications in Air Traffic Control," was given by V. I. Weihe, Air Transport Association of America. He explained the plan for fully automatic air traffic control to be started in 1963. Such a plan is becoming increasingly necessary due to the greater air speeds of today's airplanes. He described the present methods of control as cumbersome even with the latest instrumentation; automatic air control is necessary and computer engineers must fit the needs of the future into their thinking.

### RELIABILITY

The ten papers comprising the next two sessions dealt in the main with performance characteristics and results of the work accomplished by several computers with stress placed on reliability. A paper by L. D. Whitelock, U. S. Navy, Bureau of Ships, considered the methods used to improve reliability in military electronics equipment. The results of several years' study of such equipment showed that maintenance costs during its useful life vary from 10 to 100 times the cost of the equipment, that vacuum tubes are the cause of about 75 per cent of all failures, and that of the remaining failures, about 40 per cent can be charged to engineering, 25 per cent to defective components, 20 per cent to improper installation, and 10 per cent to manufacturing defects. Programs have been instituted in all cases to improve reliability.

Dr. S. N. Alexander and R. D. Elbourn presented a paper about the Bureau of Standards computer performance tests. A testing procedure was developed in conjunction with the Bureau of Census that was patterned after the sequential sampling concept used in quality-control techniques. The criteria for acceptance require remaining within specified limits on the following: accumulated total of major errors, percentage of minor errors, and total down time. The test period should extend for at least a month so that the down time is not a deceptive figure.

D. W. Sharp, Aeronautical Radio, Inc., in his paper, "Electron Tube Performance in Some Typical Military Environments," told about the project in which the Army, Navy, and Air Force are co-operating by sending to a central point all vacuum tubes which have failed for any reason, no matter in what type of equipment they were used. Tubes used in Army equipment (communication, radar, teletypewriters, and so forth) were found to have failed because of some electrical defect rather than mechanical. On the other hand, those which had been shipborne showed 22 per cent more mechanical failures than Army tubes, which was perhaps due to the jars and vibrations to which they are subjected on shipboard.

Several papers were presented covering the functioning, down time, maintenance, and reliability of ILLIAC, OARAC, Los Alamos *701*, UNIVAC, SEAC, and so forth. By and large, these case histories struck an optimistic note regarding the computers' performance.

The three papers of the final session dealt with the reliability of capacitors, resistors, and life tests of computer components. Dr. A. V. Astin, Director, National Bureau of Standards, summarized the proceedings of the conference after the final session had been held.

### PROCEEDINGS

All conference registrants will be sent a bound copy of the papers presented upon publication. Additional copies at $3.00 each may be ordered from the Institute of Radio Engineers, 1 East 79th Street, New York 21, N. Y.

### COMMITTEES

Members of the Local Arrangements Committee for the conference included Chairman Mark Swanson, Assistant Chairman A. E. Smith, and the following vice-chairmen: R. I. Cole, finance; Margaret R. Fox, inspection trips; L. R. Johnson, registration; H. N. Laden, publications; G. W. Petrie, publicity; S. F. Reed, reception and hotel; L. D. Whitelock, exhibits. The advisory staff consisted of S. N. Alexander, R. C. Bryant, E. W. Cannon, C. A. Henson, J. J. A. Jessell, C. V. L. Smith, S. B. Williams. Members of the Technical Program Committee were H. T. Engstrom, chairman; R. C. Bryant, assistant chairman; J. S. Anderson, J. J. Eachus, M. W. Swanson.

**Dr. Allen V. Astin, Director, National Bureau of Standards, presents the summary of the papers after the final session of the Eastern Joint Computer Conference in Washington, D. C.**

# AIEE Board of Directors Holds November Meeting in Kansas City

The regular meeting of the AIEE Board of Directors was held in the Hotel Phillips, Kansas City, Mo., on November 5, 1953.

BOARD OF EXAMINERS

Recommendations adopted by the Board of Examiners at meetings on September 17, and October 15, 1953, were reported and approved. The following actions were taken, upon recommendation of the Board of Examiners: 4 applicants elected to grade of Member; 134 applicants elected to grade of Associate Member; 1 Associate Member reinstated and 8 re-elected; 24 applicants elected to grade of Affiliate; 357 Student members enrolled.

Fifteen proposals for transfer to the grade of Fellow were submitted by the Board of Examiners, with a favorable recommendation and a recommended citation in each case. The Board of Directors voted to invite the following 15 Members to be transferred to the grade of Fellow:

Joseph Ashmore, District Manager, Birmingham and Midlands, British Electrical Repairs, Ltd., Church Road, Perry Barr, Birmingham 22B, England
R. D. Booth, Partner, Jackson and Moreland, 31 James Avenue, Boston 16, Mass.
F. H. Buller, Analytical Engineer, General Electric Company, Schenectady, N. Y.
R. S. Daniels, Electrical Engineering Consultant, The California Oregon Power Company, 216 W. Main Street, Medford, Oreg.
D. M. Farnham, Chief Engineer, Design Division, Quebec Hydro-Electric Commission, 107 Craig Street West, Montreal, Quebec, Canada
S. B. Farnham, Sponsor Engineering, Electric Utility Engineering Section, General Electric Company, Schenectady 5, N. Y.
Leslie Greenwood, Chief Electrical Designer (Machines), Crompton Parkinson Ltd., Chelmsford, Essex, England
R. G. Jewell, Supervisor, Meter Development Engineering, General Electric Company, 40 Federal Street, Lynn, Mass.
J. E. Jones, Manager of Drafting, Cutler-Hammer, Inc., 315 North 12th Street, Milwaukee 1, Wis.
M. M. Morack, Product Application Engineer, General Electric Company, Schenectady 5, N. Y.
Albrecht Naeter, Professor and Head, School of Electrical Engineering, Oklahoma Agricultural and Mechanical College, Stillwater, Okla.
R. C. Sogge, Manager-Standards, General Electric Company, Schenectady 5, N. Y.
J. D. Stacy, Manager, Engineering, Planning and Development, Capacitor Department, General Electric Company, Lower John Street, Hudson Falls, N. Y.
W. R. Way, Vice-President in Charge of Generation and Transmission, Shawinigan Water and Power Company, 600 Dorchester Street, West, Montreal, Quebec, Canada
C. A. Woodrow, Electric Utility Engineer, General Electric Company, Schenectady 5, N. Y.

More information regarding the aforementioned individuals appeared in the January 1954 issue in the department "AIEE Fellows Elected" (pages 89–92) and in this issue (pages 177–8).

The Board of Directors approved the recommendation of the Board of Examiners that no credit be allowed for the Engineer-in-Training Certificate, as it was the opinion of the Board of Examiners that the establishment of such a procedure would have the effect of diluting the standard of achievement necessary for admission to Associate Member grade. This question of allowing credit for the Engineer-in-Training Certificate as part of the 5 years of experience specified for the grade of Associate Member was referred to the Board of Examiners by the Board of Directors at its meeting on June 18, 1953.

EXECUTIVE COMMITTEE

The following actions of the Executive Committee on membership applications, as of September 24, 1953, were reported and confirmed: 43 applicants transferred, 5 elected, and 1 re-elected to the grade of Member; 138 applicants elected and 6 re-elected to the grade of Associate Member; 7 applicants elected to the grade of Affiliate; 46 Student members enrolled.

FINANCES

Chairman C. S. Purnell of the Finance Committee reported disbursements from the general funds for September 1953 as $74,556.68; and for October 1953 as $132,592.65.

A budget for the appropriation year ending September 30, 1954, as recommended by the Finance Committee, was submitted by Chairman Purnell, and was adopted by the Board.

A Treasurer's Report for the expired portion of the 1953–54 fiscal year was submitted by Treasurer Walter J. Barrett, and was accepted by the Board.

ACTIONS AND APPOINTMENTS

At the meeting of the Board of Directors on September 3, 1953, the Bylaws were amended to establish an Advisory Committee on Honors, consisting of six members appointed by the Board, those appointed initially to include two each for 1-year, 2-year, and 3-year terms, and thereafter two to be appointed each year for a term of 3 years, all terms starting August 1. The Board voted that initial appointments to the Advisory Committee on Honors be as follows: 3 years: T. M. Linville, E. W. Seeger; 2 years: D. A. Quarles, chairman, G. C. Tenney; 1 year: F. R. Benedict, T. G. LeClair.

The Committee on Planning and Co-ordination recommended and the Board approved and authorized the President and Secretary to sign the proposed agreement on entrance fees with The American Society of Mechanical Engineers (ASME), which was developed by the representatives of the ASME and a subcommittee of the Committee on Planning and Co-ordination. (The proposed agreement was published in the January issue of *Electrical Engineering*, page 85).

Upon recommendation of the Committee on Planning and Co-ordination, the Board authorized the holding of the 1956 Summer and Pacific General Meeting in San Francisco, Calif., June 25–29, 1956, with the understanding that this action does not set any precedent in the rotation of meetings; and the 1955 Southern District Meeting in St. Petersburg, Fla, in April, the exact dates to be fixed by the Section and District, subject to approval by the Board of Directors.

It was voted by the committee to recommend to the Committee on Technical Operations that all efforts be made to co-ordinate the programs of the Fall General Meeting with those of the National Electronics Conference in 1954, 1955, and 1956. Chairman L. F. Hickernell, of the Committee on Technical Operations, reported that this recommendation had been presented at the Committee on Technical Operations meeting on November 4, and that the committee had agreed.

Chairman L. F. Hickernell, of the Committee on Technical Operations, reported briefly upon the activities of the committee and the technical committees.

Members of the Board of Directors were selected as members and alternates to represent the Board on the AIEE Nominating Committee, as follows:

Members—C. P. Almon, Jr., W. L. Cassell, G. D. Floyd, C. M. Lytle, J. C. Strasbourger

Alternates—F. R. Benedict, A. C. Muir, C. S. Purnell

The Standards Committee reported the appointment of the following representatives on standardizing committees:

Sectional Committee *C2*, "National Electrical Safety Code"
E. L. Kanouse, representative to succeed E. W. Oesterreich, resigned
E. R. Coulbourn, alternate, to succeed D. C. Stewart, deceased

Sectional Committee *C6*, "Terminal Markings for Electric Apparatus"
R. F. Munier, representative, to succeed C. B. Hathaway, resigned

Sectional Committee *C39*, "Electric Recording Instruments"
R. Feldt, representative, to succeed E. S. Lee, resigned

Sectional Committee *C50*, "Rotating Electric Machinery"
J. deKiep, representative, to succeed S. H. Mortensen, resigned
T. H. Morgan, representative, to succeed W. I. Slichter, resigned
E. I. Pollard, alternate, to succeed J. E. Clem, resigned
J. E. Noest, additional alternate

Sectional Committee *C52*, "Electric Welding Apparatus,"
J. F. Deffenbaugh, representative, to succeed W. E. Crawford, resigned

Sectional Committee *C57*, "Transformers"
F. J. Vogel, representative, to succeed F. L. Snyder, resigned

Sectional Committee *C61*, "Electric and Magnetic Magnitudes and Units"
R. C. Machler, representative, to succeed I. M. Stein, resigned

Sectional Committee *C83*, "Electronic Components"
J. G. Reid, representative

The Standards Committee reported approval of the following Standards:

Revision of parts of AIEE Number *20*, "Low-Voltage Air Circuit Breakers"

Test Code for Carbon Brushes, Number *504*

Revision of Aircraft D-C Apparatus Voltage Ratings, Number *700*

Proposed revisions of Table 11.021 and Section *16* of the American Standard for Transformers, *C57*

Proposed revision of part of Preferred Nominal Voltages Below 100, *C67*

Revision of Measurement of Test Voltage in Dielectric Tests, ASA *C681*. (AIEE Number *4*)

EEI-NEMA Preferred Voltage Ratings for A-C Systems and Equipment, by request as an interested organization

The Board approved the use of the McAlpin Hotel for some technical sessions during the 1954 Winter General Meeting of the Ins itute. It was voted to hold the 1955 Smoker in the Hotel Statler.

The appointment of five AIEE representatives and up to five alternates on En-

gineers Joint Council for 1954 was referred to the President with power. At a later date, the following were appointed:

Representatives—Walter J. Barrett, H. H. Henline, M. D. Hooven, T. M. Linville, C. S. Purnell

Alternates—N. S. Hibshman, L. F. Hickernell, W. Scott Hill, Walter B. Morton, A. C. Muir

Upon invitation, A. C. Monteith presented a proposal from the Pittsburgh Engineering Center Committee that a new Engineering Center be erected in that city.

A meeting of the Conference of Representatives From the Engineering Societies of Western Europe and the United States of America was held in Paris, France, September 7–11, 1953, with President Robertson and Secretary Henline representing the Institute. At President Robertson's request, Secretary Henline presented a brief report upon the meeting. (A report of the meeting was published in the December 1953 issue of *Electrical Engineering*, page 1125.)

The Board approved the holding of the next meeting of the Board of Directors at Institute Headquarters, New York, N. Y., on Thursday, January 21, 1954.

The following representatives were appointed to attend the Third National Congress Meeting of the AMIME (Mexican National Engineering Organization), held in Mexico, November 29–December 5, 1953: H. M. D'Meza, Chairman, Miguel Castillo, Basil Nikiforoff, Carlos Santacruz.

ATTENDANCE

Present at the meeting were: *President* Elgin B. Robertson; *Past Presidents* F. O. McMillan, D. A. Quarles; *Vice-Presidents* C. P. Almon, Jr., A. S. Anderson, W. L. Cassell, G. D. Floyd, W. Scott Hill, M. D. Hooven, C. M. Lytle, Walter B. Morton; *Directors* F. R. Benedict, D. I. Cone, R. F. Danner, D. D. Ewing, L. F. Hickernell, A. C. Muir, C. S. Purnell, E. W. Seeger, Victor Siegfried, J. C. Strasbourger; *Treasurer* Walter J. Barrett; *Secretary* H. H. Henline; *Assistant Secretary* N. S. Hibshman.

## Pittsburgh Student Branch Reports Active Program

During the 1953–54 fall semester, the AIEE Student Branch at the University of Pittsburgh has attempted an ambitious program to increase the interest of the undergraduate students both in the AIEE and in the electrical engineering field, and to establish in the student's mind the role of the engineer in the community.

To initiate the program, an informative talk on what the AIEE is, and how it now affects and later will affect the undergraduate was given to all electrical engineering freshmen. Through an intensified membership campaign and this freshman orientation, 28 new members have been added to the student organization.

With the introduction of outside speakers, many subjects not readily available to the students were presented. On the subject, "The Inner Cooling of Generators," W. C. Brenner, Westinghouse Electric Corporation, discussed the more effective way of cooling large generators with hydrogen. A talk on safety covered its three aspects, including the detection of unsafe conditions, the protection from unsafe conditions, and the treatment of accidents. These aspects were adapted mainly to the electrical field. This talk was given jointly by John Dunn and John Sherwin, Mines Safety Appliances Company. A talk on color television explaining its differences and intricate problems as compared to black-and-white television was given by Howard Jones, director of television research at Westinghouse, while Leslie Roberts, an engineer in television research at Westinghouse, spoke on the reproduction of color and the nearness of color television for the home.

In order to show the student engineer his relationship to the community, a color film entitled "Pittsburgh Rebuilds for the Future," was obtained through the Civic Salesman League of Pittsburgh. This film showed the redevelopment of Pittsburgh and the problems that must be overcome, both engineering and civic. The commentary was given by W. Sutherland of the League.

An important training aspect of the student engineer which is not covered by any textbook is his sociability. To help students to regard the University of Pittsburgh as something more than a factory of knowledge, since it is mainly a commuter school, an active social program was initiated. This program provided a means to publicize all social functions of the university and all meetings of the Pittsburgh Section of the AIEE, and to increase the number of social gatherings of the Student Branch.

Just before graduation, the seniors will meet to hear J. T. West, Jr., secretary of the State Society of Pennsylvania Professional Engineers. He will discuss the "Advantages of Registration" and of becoming a Professional Engineer.

## 26 Past Chairmen Honored at New York Section Ceremony

Twenty-six former chairmen of the AIEE New York Section, including four past presidents of the Institute, were presented with past chairmen pins in recognition of their services at a ceremony in the auditorium of the Engineering Societies Building, New York, N. Y., on December 15, 1953. The presentation was made by Leland F. Stone, General Electric Company, Newark, N. J., the 1953–54 chairman of the Section.

The ceremony was the first of its kind held by the Section, which has a membership of 6,000 in New York City and the metropolitan area. It was to honor engineers who had served as Section chairmen each year since 1920.

Past presidents of the Institute who received pins were H. W. Buck, New York, N. Y.; Donald F. Quarles, United States Assistant Secretary of Defense for Research and Development; James F. Fairman, vice-president, Consolidated Edison Company of New York, Inc.; and H. P. Charlesworth of South Orange, N. J.

Other past chairmen receiving the pins were the following: H. H. Barnes, retired; H. A. Kidder, retired; R. H. Tapscott, chairman of the board, Consolidated Edison Company; J. B. Bassett, General Electric Company; O. H. Caldwell, editor, *Tele-Tech;* T. F. Barton, retired; C. R. Jones, Westinghouse Electric Corporation; W.

## Future AIEE Meetings

**AIEE-IRE-ACM West Coast Computer Conference**
Ambassador Hotel, Los Angeles, Calif.
February 11–12, 1954
(*Final date for submitting papers—closed*)

**AIEE-IRE Conference on Transistor Circuits**
University of Pennsylvania Museum Auditorium, Philadelphia, Pa.
February 18–19, 1954
(*Final date for submitting papers—closed*)

**Conference on Rubber and Plastics**
Mayflower Hotel, Akron, Ohio
April 5–6, 1954
(*Final date for submitting papers—closed*)

**Southern Textile Conference**
A. French Textile School of Georgia Institute of Technology, Atlanta, Ga.
April 15–16, 1954
(*Final date for submitting papers—closed*)

**Conference on Feedback Control**
Claridge Hotel, Atlantic City, N. J.
April 21–23, 1954
(*Final date for submitting papers—closed*)

**AIEE-IRE-RETMA-WCEMA Electronic Components Conference**
Washington, D. C.
May 4–6, 1954
(*Final date for submitting papers—February 4*)

**North Eastern District Meeting**
Van Curler Hotel, Schenectady, N. Y.
May 5–7, 1954
(*Final date for submitting papers—February 4*)

**Appliance Technical Conference**
Morrison Hotel, Chicago, Ill.
May 17–19, 1954
(*Final date for submitting papers—February 19*)

**Electric Welding Conference**
Milwaukee, Wis.
May 19–21, 1954
(*Final date for submitting papers—February 19*)

**AIEE-IAS-IRE-ISA Conference on Telemetering**
Morrison Hotel, Chicago, Ill.
May 24–26, 1954
(*Final date for submitting papers—February 25*)

**Summer and Pacific General Meeting**
Biltmore Hotel, Los Angeles, Calif.
June 21–25, 1954
(*Final date for submitting papers—March 23*)

**Middle Eastern District Meeting**
Abraham Lincoln Hotel, Reading, Pa.
October 5–7, 1954
(*Final date for submitting papers—July 7*)

**Fall General Meeting**
Morrison Hotel, Chicago, Ill.
October 11–15, 1954
(*Final date for submitting papers—June 14*)

**Machine Tool Conference**
Detroit, Mich.
November 8–10, 1954
(*Final date for submitting papers—August 8*)

**1955 Winter General Meeting**
Hotel Statler, New York, N. Y.
January 31-February 4, 1955
(*Final date for submitting papers—November 1*)

**New York Section Chairman L. F. Stone presents a past chairman pin to H. W. Buck, 80, oldest living past president of the Institute and first chairman of the New York Section. Front row, left to right: R. T. Oldfield, A. G. Oehler, H. H. Barnes, H. W. Buck, L. F. Stone, M. D. Hooven, J. F. Fairman, H. P. Charlesworth, J. D. Tebo. Back row, left to right: J. P. Newbauer, C. C. Whipple, J. L. Callahan, D. W. Taylor, George Sutherland, C. R. Jones, J. A. Parrott, A. F. Dixon, H. H. Henline, C. S. Purnell, N. S. Hibshman**

R. Smith, Bell Telephone Laboratories; C. R. Beardsley, retired; A. G. Oehler, Simmons-Boardman Company; A. F. Dixon, Bell Telephone Laboratories; George Sutherland; C. C. Whipple, Brooklyn Polytechnic Institute; C. S. Purnell, Westinghouse Electric Corporation; M. D. Hooven, Public Service Gas and Electric Company; J. L. Callahan, Radio Corporation of America; W. J. Barrett, New Jersey Bell Telephone Company; R. T. Oldfield, New York Public Service Commission; D. W. Taylor, Public Service Gas and Electric Company; J. D. Tebo, Bell Telephone Laboratories; J. P. Neubauer, Consolidated Edison Company; and J. A. Parrott, American Telephone and Telegraph Company.

Mr. Buck, who served as Section chairman in 1920–21, is the oldest living past president of the Institute, which he headed in 1916–17. He was born in New York on May 7, 1873, and was with the Niagara Falls Power Company from 1900 until he retired in 1950. He received his electrical engineering degree from the Columbia School of Mines in 1895. Mr. Buck became a member of the Institute in 1895 and was elected a fellow in 1912.

## Summer and Pacific Meeting Site Offers Vacation Possibilities

Plans for the 1954 AIEE Summer and Pacific General Meeting at the Biltmore Hotel in Los Angeles, Calif., June 21–24, have crystallized in many particulars. While it is not possible at this early date to comment on the technical sessions, it is timely to suggest that 1954 vacation plans be built around the meeting. The committee welcomes inquiries regarding routes to Los Angeles by rail, air, or automobile.

A number of interesting activities have been planned in conjunction with the meeting. For the ladies these will include a fashion luncheon, a visit to Padua Hills Theater (Mexican players) at Claremont, the Huntington Library in San Marino, and a tour of the ocean beaches with luncheon at the Wilshire Country Club.

Two of the evening trips for the members will be devoted to the television industry: On Monday, the Columbia Broadcasting System studios in Los Angeles and the National Broadcasting Company studios in Burbank will be visited and on Tuesday the nine television transmitter stations on Mt. Wilson, 5,700 feet above the metropolitan area and 17 miles from Hollywood, will be opened for inspection. The Mt. Wilson Observatory with the 100-inch telescope also will be open to the members.

Wednesday evening will be devoted to a visit to Knott's Berry Farm and dinner at the restaurant in Buena Park. The 75-mile round trip will afford an opportunity to view the intense industrial and agricultural development in Los Angeles and Orange Counties, and the tour of the farm will turn the calendar back 100 years to the Gold Rush era.

## Cisler Discusses Atomic Power at Meeting of New York Section

W. L. Cisler, president, Detroit (Mich.) Edison Company, was the guest speaker at the meeting of the New York Section of the AIEE, December 15, 1953. Subject of Mr. Cisler's talk was "Progress Toward Nuclear Power."

Mr. Cisler made special mention of President Eisenhower's proposal for the civilian use of atomic energy to supplement the conventional sources of energy. He called the President's speech the beginning of a world-wide movement to harness atomic energy for the benefit of mankind.

The great problem connected with the civilian use of the atom for power is how the matter of harnessing atomic energy for peacetime purposes can be accomplished within the framework of our whole national economy and competitive industrial system, Mr. Cisler declared.

Development of atomic power must be along four main channels, he said. These are the technical and engineering, the economic and commercial, the legal and governmental, and the managemental.

Mr. Cisler stressed that the Atomic Energy Act of 1946 must be modified to permit private industries to own and operate atomic power installations and fissionable material before further steps can be taken with regard to nuclear power plants.

Mr. Cisler then discussed the various

**Shown at an executive meeting to consider arrangements for the 1954 Summer and Pacific General Meeting are, seated, left to right: C. A. Wells, secretary, general committee; Bradley Cozzens, chairman, general committee; Mrs. E. K. Sadler, chairman, ladies' committee; E. K. Sadler, vice-chairman, general committee. Standing, left to right, are the following meeting committee chairmen: C. Allen, entertainment; E. W. Morris, technical program; C. Croft, hotels; H. A. Lott, finance; R. A. Young, transportation; E. Niemoller, publicity; L. L. Grandi, students; H. J. Wheeler, registration; R. L. Engle, inspection trips; C. L. Sidway, arrangements (representing R. L. Milmoe)**

**Leland Stone (left), New York Section chairman, with W. L. Cisler, speaker at the Section meeting on nuclear power**

types of nuclear reactors and emphasized that the breeder type of reactor appears to be the only one which could be competitive with conventional power suppliers. Mr. Cisler pointed out that unless atomic fuels were competitive with conventional fuels they would not come into wide use or be economically successful.

Costs of a conventional power plant and a nuclear plant then were compared. At the present time on the basis of cost, Mr. Cisler said, it would seem that it would not be possible to substitute nuclear reactors for the conventional plant.

Great progress in solving technical problems involved in nuclear reactors has been made, he declared and added that much will be accomplished in the next year because of the great research endeavors now in progress.

Mr. Cisler said he felt it was more important to have people deeply interested in the problem of nuclear power than either money or materials. He urged continued interest in the problem by the AIEE and its members. Only by finding widespread applications for atomic power and its byproducts can it benefit all peoples, he concluded.

## Washington University Branch to Mark 50th Anniversary

A celebration in commemoration of the 50th anniversary of the founding of the AIEE Student Branch at Washington University in St. Louis, Mo., will begin with a banquet on February 4, 1954. The Branch was founded on February 5, 1904.

Speaker at the banquet will be Dr. A. S. Langsdorf, first chairman and organizer of the Branch. Dr. Langsdorf was dean of the Schools of Engineering and Architecture and professor of electrical engineering at Washington University for many years. Although now on emeritus status, he is actively engaged in the revisions of his textbooks on a-c and d-c machinery, and in professional, scientific, and civic societies.

Other activities in commemoration of the anniversary will include a stag party for students and faculty and a beard-growing contest among the students, and will culminate in an extensive display during the Annual Engineers' Day Exposition at the university on March 18–20.

The earliest available record of the student organization is found in the first edition in 1906 of the *Hatchet*, yearbook of Washington University. It shows Dr. Langsdorf as chairman and Theodore Kargau, Edward Ballman, C. R. Butler, W. E. Bryan, G. L. Evans, George Mezger, N. F. Rehm, A. R. Butler, E. J. Birkner, M. C. Cave, W. E. Ligget, P. A. Richardson, and W. E. Weidmann as members. Four members of this group are shown in the accompanying illustration which includes present Branch officers.

According to its chairman, Denmer Baxter, the Student Branch at Washington University is very active at present. Its monthly meetings have included addresses by leading electrical engineers from the St. Louis area, and the Branch recently visited the Research Center of the St. Louis Institute for the Deaf which does research in communication.

Invited to participate in the 50th anniversary celebration are all former members of the Branch, Student members from nearby engineering schools, and members of the AIEE St Louis Section.

**Front row, left to right: Dr. Langsdorf; W. E. Bryan, an early secretary of the Branch and now secretary of the Engineers' Club of St. Louis; W. E. Weidmann, president, Belleville Shoe Manufacturing Company; Edward Ballman, president, Baldor Electric Company. Back row, left to right: Dr. P. M. Honnell, Branch counsellor 1947–53; R. E. Horn, present counsellor; Richard Guenther, secretary; John Brune, treasurer; Denmer Baxter, chairman; Morris Scheer, vice-chairman; Dr. R. J. W. Koopman, head, department of electrical engineering**

**Members of the present Washington University Student Branch are, front row, left to right: D. J. Steinmeyer, Richard Sandefur, Morris Scheer, Denmer Baxter, Richard Guenther, John Brune, Elliott Chubb, Thomas Bryan, Melvin Tash. Back row, left to right: Kenneth Mengersen, R. C. Patterson, Byron Douglas, Alvin Bush, Earl West, E. R. Specht, Edwin Betzold, Theodore Wohlman, James Miller**

## Conference on Transistor Circuits Will Emphasize Research Trends

Final plans have been made for the Conference on Transistor Circuits to be held in Philadelphia, Pa., February 18–19, 1954. The conference will be sponsored jointly by the Institute of Radio Engineers Professional Group on Circuit Theory and the AIEE Science and Electronics Division.

The papers to be presented have been selected to appeal to engineers who are already familiar with transistor operation. They deal with either junction transistors or the new surface-barrier transistors, and, on the whole, reflect the present state of research and development in the transistor circuit field. For complete details of the technical program, see the January issue of *Electrical Engineering*, page 85.

The University of Pennsylvania is host to the conference and has offered the facilities of the University Museum for the sessions. A block of rooms for those attending has been reserved at the Penn-Sherwood Hotel.

Lunch will be served in the Rotunda of the University Museum on both Thursday

and Friday. Luncheon tickets will be $2.50 if purchased before February 13, or $2.75 at the time of the conference. Cocktails and a buffet supper will be served at the Penn-Sherwood Hotel on Thursday evening. Tickets are $4.50 in advance, or $5.00 after February 13. Advance purchase of luncheon or supper tickets is recommended.

Advance registration for the conference is urged as facilities are limited. Registration and hotel reservation forms may be obtained from L. H. Good, RCA Victor Building, 10–5, Camden, N. J. The advance registration fee for the conference is $3.00. The fee for those who register after February 13 will be $4.00.

## Central Indiana Section Awards Past Chairman Pins

Among the first of the AIEE Sections to honor its past chairmen with the recently authorized lapel pin was the Central Indiana Section. At its December 1953 meeting in Indianapolis, Ind., 18 former presiding officers received these awards from Dr D. D. Ewing, head of the Purdue University School of Engineering and an AIEE Director.

Recipients of the pins were the following: E. L. Carter, Consulting Engineer; C. E Chatfield, Manufacturers' Agent; C. A. Cora, retired; L. J. Dunnewold Indiana Bell Telephone Company; P. B. Ewing Indiana Bell Telephone Company; G. M. Grabbe, Allison Division of General Motors; J. G. Harden, Indiana Bell Telephone Company; E. G. Hinshaw, Indiana Bell Telephone Company; S. C. Leibing, General Electric Company; C. E. Parks, Public Service Company of Indiana; J. R. Pies, Industrial Development Engineering Association; J. W. Sears, Indiana Bell Telephone Company; R. A. Scholl, Public Service Company of Indiana; F. L. Stanley, Indiana Bell Telephone Company; C. R. Swenson, Indiana Bell Telephone Company; G. F. Switzer, Indianapolis Power and Light Company; J. M. Webb, Eli Lilly and Company; C. A. Wilson, Roots-Connersville Blower Division.

In his address, Dr. Ewing discussed "Institute Activities," and Guy Guthrie, present Section chairman, supplemented the subject with film slides, "This Is Your Institute," showing excerpts from the Report of the Board of Directors.

The Section plans to follow up its initial awards on an annual basis as present and future chairmen retire.

**Among Central Indiana Section recipients of the past chairman lapel emblems are, standing, left to right: C. E. Chatfield, R. A. Scholl, D. D. Ewing (who presented awards), C. A. Cora, C. R. Swenson, C. E. Parks, J. G. Harden, E. G. Hinshaw, S. C. Leibing. Seated, left to right: G. F. Sitzer, J. R. Pies, G. M. Grabbe, C. A. Wilson, J. W. Sears, P. B. Ewing**

## AIEE Nominating Committee Meets in New York City

The Nominating Committee of the AIEE met at the Hotel Statler, New York, N. Y., January 19, 1954, during the Winter General Meeting of the Institute, to nominate candidates for AIEE offices to be voted on by the membership in the spring of 1954. Members of the committee are as follows.

Representing the Board of Directors:

C. P. Almon, Jr., Tennessee Valley Authority, Chattanooga, Tenn.

W. L. Cassell, Iowa State College, Ames, Iowa

G. D. Floyd, Hydro-Electric Power Commission of Ontario, Toronto, Ont., Canada

C. M. Lytle, Kansas City Power and Light Company, Kansas City, Mo.

J. C. Strasbourger, Cleveland Electric Illuminating Company, Cleveland, Ohio

Alternates for Board representatives:

Frank R. Benedict, Westinghouse Electric Corporation, Boston, Mass.

A. C. Muir, Berwind-White Coal Mining Company, Philadelphia, Pa.

C. S. Purnell, Westinghouse Electric Corporation, New York, N. Y.

Representing the ten geographical Districts:

1. F. S. Bacon, Winchester, Mass.
2. A. A. Johnson, Westinghouse Electric Corporation, East Pittsburgh, Pa.
3. L. F. Stone, General Electric Company, Newark, N. J.
4. Walter J. Seeley, Duke University, Durham, N. C.
5. J. R. North, Commonwealth Services, Inc., Jackson, Mich.
6. O. E. Edison, University of Nebraska, Lincoln, Nebr.
7. H. O. Hodson, Southwestern Public Service Company, Amarillo, Tex.
8. J. H. Vivian, Southern California Edison Company, Los Angeles, Calif.
9. H. C. Glaze, General Electric Company, Spokane, Wash.
10. J. A. Williamson, Hydro-Electric Commission of Niagara Falls, Niagara Falls, Ont., Canada

Alternates for District representatives:

2. R. H. Greame, Westinghouse Electric Corporation, Charleston, W. Va.
3. J. R. Kerner, Westinghouse Electric Corporation, Newark, N. J.
4. Fred H. Pumphrey, University of Florida, Gainesville, Fla.
6. Henry L. Meyer, Consumers Public Power District, York, Nebr.
7. H. J. Kongabel, Westinghouse Electric Corporation, Houston, Tex.
8. E. W. Morris, Westinghouse Electric Corporation, Los Angeles, Calif.
9. R. M. Gilbert, Westinghouse Electric Corporation, Spokane, Wash.

Representing the five technical divisions:

Communication Division—H. A. Affel, Bell Telephone Laboratories, Murray Hill, N. J.

General Applications Division—L. W. Birch, Ohio Brass Company, Mansfield, Ohio

Industry Division—E. U. Lassen, Cutler-Hammer, Inc., Milwaukee, Wis.

Power Division—B. G. A. Skrotzki, Associate Editor *Power*, New York, N. Y.

Science and Electronics Division—W. R. Clark, Leeds and Northrup Company, Philadelphia, Pa.

Alternates for Division representatives:

Communication Division—I. S. Coggeshall, Western Union Telegraph Company, New York, N. Y.

General Applications Division—R. L. Oetting, General Electric Company, Cleveland, Ohio

Industry Division—G. W. Heumann, General Electric Company, Schenectady, N. Y.

Power Division—C. T. Hatcher, Consolidated Edison Company, New York, N. Y.

Science and Electronics Division—S. R. Warren, Jr., University of Pennsylvania, Philadelphia, Pa.

## Villanova Student Branch Reports Smoker, Field Trips

The Joint AIEE–Institute of Radio Engineers Student Branch at Villanova College recently participated in a joint smoker with members of the American Society of Civil Engineers and also made two interesting field trips. Joseph Zator is the Branch chairman.

The smoker, which was held on November 17, 1953, was attended by 89 persons, including 37 AIEE members. Featured speakers were A. F. Dagit, architect, and J. R. Farrell, contractor, who discussed their work in the designing and construction of a new dormitory on the campus.

The first of the field trips was taken on November 18 to the new dial system building of the Bell Telephone Company in Ardmore, Pa. The tour included the long-distance switchboard, relaying system, power supply, and other automatic devices involved in dial operation.

On the other trip the students visited the Philadelphia Navy Yard. They toured the electrical shop where all types of electric

motors are torn down to be refinished and rewound, the machine shop where the propellers are given their proper pitch and valve repair is carried on, and the instrument shop where the repair and operating principles of the gyroscope were explained. The trip was ended by a tour through a World War II submarine.

## Digital Storage Devices to Be Symposium Subject

A Symposium on Digital Storage Devices will be sponsored by the Philadelphia Sections of the AIEE and the Institute of Radio Engineers (IRE) under the supervision of the local chapters of the IRE Professional Group on Electronic Computers and the AIEE Computer Discussion Group. The symposium is to be held at the Harrison Laboratories, University of Pennsylvania, on six consecutive Tuesday evenings, starting February 9, 1954.

The topics and speakers are as follows:

*February 9*—"Ferroelectric Storage Devices," J. R. Anderson, Bell Telephone Laboratories

*February 16*—"Magnetic Drums and Tapes," S. N. Alexander, J. Rabinow, National Bureau of Standards

*February 23*—"Ferromagnetic Storage Devices," T. H. Bonn, Eckert-Mauchly Division, Remington Rand

*March 2*—"Electrostatic Storage Devices," J. Pomerene, Institute for Advanced Study, Princeton University

*March 9*—"Acoustic Storage Devices," J. Koch, Technitrol

*March 16*—"Summary and Evaluation," A. Samuels, International Business Machines

Admission for the series is $3.00 for professional society members, $4.00 for nonmembers, and $1.00 for individual sessions. Additional information may be obtained from the symposium chairman, Stanley B. Disson, Burroughs Corporation, 511 North Broad Street, Philadelphia 23, Pa.

## North Eastern District Meeting Will Be Held in Schenectady

**Chairmen of committees for the 1954 North Eastern District Meeting are, standing, left to right: O. G. Owens, student activities; A. K. Raney, publicity; W. A. Hunter, treasurer; B. R. Shepard, printing; L. A. Umansky, technical program. Seated, left to right: J. C. White, social; E. S. Lee, advisor; Mrs. W. C. White, ladies' program; D. E. Garr, general chairman; P. L. Alger, advisor. Not present: R. Cutts, finance; R. W. McFall, hotel arrangements; K. K. Bowman, registration; W. R. Kettenring, inspection trips; E. W. Hutton, banquet**

The 1954 AIEE North Eastern District Meeting will be held May 5–7 in Schenectady, N. Y. Headquarters for the meeting will be at the Hotel Van Curler.

An interesting technical program is being arranged. Two days will be devoted to technical sessions covering the following subjects: Power Generation, Magnetic Amplifiers, Instruments and Measurements, Power Systems, Service Continuity, Control, Transportation, Rotating Machinery, Computers in Engineering Analysis, Semiconductors, Transformers and Capacitors, Industrial Power Systems, Research (transition from research to engineering). The third day will feature special conferences on nucleonics and textiles.

A number of field trips are being scheduled. These probably will include the American Locomotive Works, Bell Telephone Company, General Electric Research and Knolls Atomic Power Laboratories, and the new Albany Steam Plant of the Niagara Mohawk Power Company.

A well-rounded entertainment program is being worked out for both members and the ladies who attend. There will be a ladies' headquarters room at the Hotel Van Curler and a schedule of ladies' activities is planned for the 3 days of the meeting.

Requests for accomodations should be sent, as early as possible, directly to the Hotel Van Curler and should mention the fact that they are in connection with the AIEE North Eastern District Meeting.

## Prize Awards Announced for Institute and Student Papers

The Committee on Award of Institute Prizes, E. I. Green, chairman, has announced the award of Institute Paper Prizes in each of the five technical classes for papers presented during the period August 1, 1952, to July 31, 1953.

The papers selected for first and second prizes are as follows:

**Communication Division**

*First Prize:*

"New General-Purpose Relay for Telephone Switching Systems," A. C. Keller, Bell Telephone Laboratories, Inc., New York, N. Y.

*Second Prize:*

"The Development of Telephony in the United States," A. B. Clark, Bell Telephone Laboratories, Inc., New York, N. Y.

**General Applications Division**

*First Prize:*

"An Interurban Becomes a Railroad," C. H. Jones, Chicago, South Shore and South Bend Railroad, Michigan City, Ind.

*Second Prize:*

"Controlling D-C Arcs," R. L. Hurtle, General Electric Company, Erie, Pa.

**Industry Division**

*First Prize:*

"Voltage Rating Versus Horsepower of Synchronous and Induction Motors," C. E. Miller, General Electric Company, Schenectady, N. Y.

*Second Prize:*

"A-C Distribution in Open-Pit Copper Mines," F. Berra, D. B. Carson, and C. A. Poppino

**Power Division**

*First Prize:*

"Techniques in Handling Load Regulating Problems on Interconnected Power Systems," C. Nichols, Leeds and Northrup Company, Philadelphia, Pa.

*Second Prize:*

"Short-Circuit Capabilities of Synchronous Machines for Unbalanced Faults," P. L. Alger, R. F. Franklin, C. E. Kilbourne, and J. B. McClure, General Electric Company, Schenectady, N. Y.

**Science and Electronics Division**

*First Prize:*

"Preliminary Development of a Magnettor Current Standard," E. P. Felch, Bell Telephone Laboratories, Inc., Murray Hill, N. J., and J. L. Potter, Rutgers University, New Brunswick, N. J.

*Second Prize:*

"A-C Null-Type Recorder With Balancing Amplifier Which Provides Damping and Suppresses the Quadrature Component," A. J. Williams, Jr., and J. F. Payne, Jr., Leeds and Northrup Company, Philadelphia, Pa.

STUDENT PAPERS

The Committee on Award of Institute Prizes also has announced the award of the

Best Student Paper Prizes for papers presented during the period August 1, 1952, to July 31, 1953. The committee has reviewed all of the papers submitted for this prize, six reviews having been secured for each of the seven best papers.

The papers selected for the awards are as follows:

### Best Student Paper Prize

"Some Observations of a Liquid Dielectric Stressed by High Voltage to the Point of Breakdown," R. K. Baird, South Dakota School of Mines and Technology

### Second Prize Student Paper

"Transient Response of the Saturable Reactor as Applied in Industrial Waste Precipitation," Richard Farrelly, Manhattan College

## AIEE Philadelphia Section Reports December Meeting

A Prize Paper award and a panel discussion on safety were featured at the December 14, 1953, meeting of the AIEE Philadelphia Section.

AIEE Vice-President Walter B. Morton awarded the first prize certificate to the winners of the District Prize Paper Competition. The winning paper, "Application of Electric and Acoustic Impedance Measuring Techniques to Problems in Diathermy," was written by E. L. Carstensen, associate, Moore School of Electrical Engineering, University of Pennsylvania, and Herman Schwan, assistant professor of physics in medicine, Medical School, and assistant professor of electrical engineering at the University of Pennsylvania.

After the presentation, the meeting was turned over to R. W. Wilbraham, United Engineers and Constructors, Inc., the moderator of the following panel on the subject of "Electrical Safety": Dr. M. S. Viteles, Philadelphia Electric Company, who discussed "The Psychological Aspects of Accident Prevention"; P. D. Barton, Sun Oil Company, "Electrical Safety from Management Viewpoint"; and R. L. Lloyd, National Bureau of Standards, who discussed "Electrical Safety in the Home."

## Trends in Computers to Be Los Angeles Conference Theme

"Trends in Computers: Automatic Control and Data Processing" will be the theme of the Western Computer Conference and Exhibit to be held at the Ambassador Hotel, Los Angeles, Calif., February 11–12, 1954. In addition to the AIEE, the sponsors will be the Institute of Radio Engineers, the Association for Computing Machinery, and the West Coast Electronic Manufacturers Association.

As indicated by the accompanying program, there will be two parallel sessions on the afternoons of both days. W. W. McDowell, Director of Engineering, International Business Machines Corporation, will give the keynote address at the opening session on Thursday morning and on Friday morning five parallel group discussions will be held. The program follows:

### Thursday, February 11

#### Morning. Opening Session

Welcome: Dr. D. H. Lehmer, professor of mathematics, University of California at Berkeley

Keynote Address: W. W. McDowell, Director of Engineering, International Business Machines

#### Afternoon. Session 1. Automatic Control (Design)

Chairman: Dr. John M. Salzer, Hughes Aircraft Company, Culver City, Calif.

**An Experimental Digital Flight Control System.** *Maier Margolis*, J. B. Rea Company, Inc.; *Eric Weise*, Dynalysis, Inc., Los Angeles, Calif.

**The DIGITAC Air-Borne Control System.** *E. E. Bolles, D. W. Burbeck, W. E. Frady, E. M. Grabbe*, Hughes Research and Development Laboratories, Culver City

**Use of Operational-Digital Techniques for a Simple Process Instrumentation.** Laboratory for Electronics, Boston, Mass.

**Machine Tool Control Operating Through a Digital Analogue Computer.** *Harry Mergler*, National Advisory Committee for Aeronautics, Cleveland, Ohio

**Experiments With a Digital Computer in a Simple Control System.** *Thomas Burns, J. D. Cloud, J. M. Salzer*, Hughes Research and Development Laboratories, Culver City, Calif.

### Thursday, February 11

#### Afternoon. Session 2. Data Processing (Design)

Chairman: Richard Canning, University of California at Los Angeles

**Survey Paper.** *Dr. Oliver Whitby*, Stanford Research Institute, Palo Alto, Calif.

*Typical Business Problem:*

**Unit Control Ready-to-Wear Department.** *S. J. Shaffer*, Controller, May Company, Los Angeles, Calif.

**Computer Characteristics.** *Dr. H. D. Huskey*, Institute for Numerical Analysis, Los Angeles, Calif.

**System Engineering.** *Raymond Davis*, Librascope, Burbank, Calif.

**Programming.** *M. J. Mendelson*, Computer Research Corporation, Hawthorne, Calif.

#### Evening. Cocktail Party

### Friday, February 12

#### Morning. Parallel Discussion Groups

1. Unit Control in Retail Operations
2. Numerical Control of Chemical Processes
3. Numerical Control of Machine Tools
4. Maintenance Requirements for Business Computers
5. Mathematical Methods in Management Programming

#### Noon. Luncheon

Toastmaster and speaker to be announced

### Friday, February 12

#### Afternoon. Session 3. Automatic Control (Hardware)

Chairman: Roger Sisson, Computer Research Corporation, Hawthorne, Calif.

**Survey of Analogue-Digital Conversion Techniques.** *A. Susskind*, Massachusetts Institute of Technology

**High-Speed Multichannel Analogue-Digital Conversion.** *J. Mitchell*, J. B. Rea Co., Inc., Los Angeles

**Shaft to Digital Converter.** *B. Gordon*, Laboratory for Electronics, Boston, Mass.

**High-Speed Digital Computer for Control Applications.** *C. Eldert*, Moore School of Engineering, University of Pennsylvania

**Input Switching System.** *W. S. Shockency*, Hughes Aircraft Company, Culver City, Calif.

#### Afternoon. Session 4. Data Processing (Hardware)

Chairman: Harry Burke, Consolidated Engineering Corporation, Pasadena, Calif.

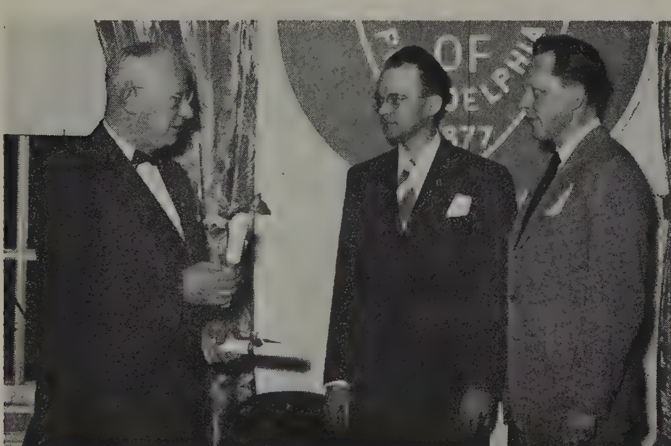
**IBM Calculator 650: Engineering and Design Consideration.** *E. S. Hughes, Jr.*, International Business Machines, Inc.

**Design Features of Remington Rand Speed Tally.** *J. L. Hill*, Engineering Research Associates, St. Paul, Minn.

**The ELECOM 125 Business System.** *Norman Grieser.*

**A Centralized Data-Processing System.** *J. J. Dober*, Flight Research, Edwards Air Force Base, United States Air Force

**A Merchandising Control System.** *W. L. Martin*, Telecomputing Corporation, Burbank, Calif.



Vice-President Morton (left) presents a first prize certificate to E. L. Carstensen and Herman Schwan (right)

# COMMITTEE ACTIVITIES

*Editor's Note: This department has been created for the convenience of the various AIEE technical committees and will include brief news reports of committee activities. Items for this department, which should be as short as possible, should be forwarded to R. S. Gardner at AIEE Headquarters, 33 West 39th Street, New York 18, N. Y.*

## Power Division

**Committee on Protective Devices** (*A. A. Johnson, Chairman; E. G. Norell, Vice-Chairman; E. M. Hunter, Secretary*). The

committee has several very interesting, timely, and somewhat controversial projects. These involve four guides and two AIEE Standards. The three guides on grounding of different types of systems—namely, (*a*) Synchronous Generator Systems, (*b*) Transmission Systems, and (*c*) Ground Fault Neutralizer Grounded Systems—are now before the Standards Committee for approval. With this approval these guides can be made available as separate pamphlets distinct from *Transactions*. There are now several points of disagreement which should be cleared up sufficiently well so that Standards Committee approval will be secured. The fourth guide, which is on Lightning Arrester Application, is being held in a temporarily inactive state due principally to important industry changes in the characteristics of arresters and further clarification of testing and application ideas.

The two AIEE Standards referred to are Number *28-A*, Valve- and Expulsion-Type Lightning Arresters, and Number *32*, Grounding. Both of these standards are being revised and brought up to date. These revisions involve fundamental definitions, procedures, and functional specifications, all of which are subject to many opinions. Some progress has been made.

In addition, the committee has projects under consideration on subjects such as Lightning Protection of Aerial Cable, Direct Stroke Protection of Substations, Shunting of Reactors, and Reducing Ground Resistance on Transmission Systems. Some work has been done on these projects, and additional work is in progress.

**Committee on Transformers** (*J. A. Adams, Chairman; J. R. Meador, Vice-Chairman; M. H. Pratt, Secretary*). A meeting of the Committee on Transformers was held in New York, N. Y., October 27, 1953. Status of projects on which they are working:

*Subcommittee on Dielectric Tests*. A test code for power factor testing of oil-immersed transformers is being reviewed.

A revision of the table of dielectric tests for oil-immersed transformers has been approved.

Test voltages for transformers for systems above 230 kv are under consideration but definite progress depends on the establishment of basic insulation levels. Maximum design voltage is a factor in this study.

Attempts to obtain data on surge voltages to which transformers may be subjected have not produced definite results. A study is under way to obtain data on the switching surge strength of transformer insulations.

*Subcommittee on Insulation Life*. The Committee on Transformers has approved 110 degrees centigrade for the temperature rise for class *B* insulation in dry-type equipment.

Since pilot tests to determine the temperature-life characteristics of insulation for dry-type transformers by the component method were not conclusive, a model for functional testing of these insulations is being developed.

Changes to the short-circuit sections of the transformer standards are still under review.

A working group has been set up to prepare a revision of the Guide for Loading Oil-Immersed Distribution and Power Transformers.

The Proposed Guide for Operation and Maintenance of Dry-Type Transformers With Class *B* Insulation will be reviewed and resubmitted for approval as a completed guide. During the period for which it was published for trial use no comments were received.

Insulation requirements for specialty transformers are to be reviewed.

*Subcommittee on Insulating Fluids*. This subcommittee plans to prepare a guide for the reclamation of transformer oils.

*Subcommittee on Magnetic Behavior*. The Working Group on Audible Noise has prepared a report on Transformer Loudness and Measurement Methods. It also is planning a study of applications as related to the transformer noise problem.

*Subcommittee on Performance Characteristics*. Revised Reactor Standards were approved by the Committee on Transformers.

A working group is being formed to revise the Instrument Transformer Test Code.

### Science and Electronics Division

**Committee on Computing Devices** (*F. J. Maginniss, Chairman; E. L. Harder, Vice-Chairman; S. H. Dodd, Jr., Secretary*). A Bibliography Subcommittee is active under the direction of Dr. J. W. Mauchly of Remington Rand and has a computer bibliography nearing completion, including short abstracts of each item, which probably will be presented in January 1954.

A Subcommittee on Digital Computer Comparisons has begun operations under the direction of W. H. MacWilliams, Jr., Bell Telephone Laboratories, Whippany, N. J. Anyone having made comparisons which might be contributed to this effort should contact Dr. MacWilliams.

The other subcommittee chairmen, G. G. Hobert, Philadelphia, Pa., (digital computers); Dr. G. D. McCann, California Institute of Technology, Pasadena, Calif. (analogue computers); and C. R. Wayne, Syracuse, N. Y. (analogue-digital conversion devices) will be glad to receive suggestions for session topics, papers, or projects which should be carried on in their respective fields.

Suggestions or questions regarding the functioning of this committee should be addressed to the chairman, F. J. Maginniss, Analytical Engineering Department, General Electric Company, Schenectady, N. Y.

**Committee on Electronics** (*H. C. Steiner, Chairman; J. D. Ryder, Vice-Chairman; D. G. Wilson, Secretary*). J. G. Reid, Jr., has been appointed as a representative to the American Standards Association (ASA) Committee *83* on Electronic Components. Professor E. M. Boone will serve as liaison representative to the Institute of Radio Engineers (IRE) Committee on Electron Devices.

*Subcommittee West* (*B. S. Graham*). This subcommittee has been established to provide closer liaison with the work in electronics that is being accomplished on the West Coast. Plans are being made for the technical program that will be sponsored by the Committee on Electronics at the 1954 Summer and Pacific General Meeting.

*Subcommittee on Electrostatic Processes* (*H. J. White*). Work has continued during the year on the formulation of standards for electric power supplies for electrostatic precipitation. A series of papers will be presented at the 1954 Winter General Meeting covering radioactive static eliminators and various types of electric and electronic equipment of current interest in the field of electrostatic precipitation and spray painting.

*Subcommittee on Electron Tubes* (*R. E. Higgs*). The cathode-ray tube working group has completed its work on storage tube definitions and these have been passed through the Committee on Electronics to the ASA for consideration. Plans now are under way to take up standardization of definitions for color-television tubes.

The gas tube and phototube working group has obtained response from the IRE Subcommittee on Gas Tubes indicating that a joint session will be held soon in an effort to obtain common proposals on gas tube definitions for submission to the ASA.

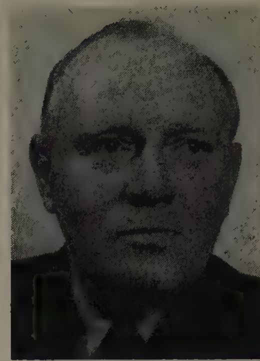
# AIEE FELLOWS ELECTED..

### Board of Directors Meeting, November 5, 1953

**Joseph Ashmore** (AM '21, M '30), district manager, Birmingham and Midlands, British Electrical Repairs Ltd., Birmingham, England, has been transferred to the grade of Fellow in the AIEE "for distinction as an executive of a large organization specializing in the construction, modernization, and repair of electric systems, equipment, switchgear testing facilities and lighting installations." Mr. Ashmore was born in Manchester, England, July 26, 1897, and attended the College of Technology, Manchester, and the Royal Technical College. From 1919 to 1923 he was with the engineering department, British Engine Boiler and Electrical Insurance Company Ltd., Manchester. He inspected electrical plants, lifts, and lighting installations and was responsible to the Royal Insurance Company for inspections at works of Metropolitan Vickers Electrical Company Ltd., to guarantee being insured. Since 1923, he has been district manager, Birmingham and Midlands, British Electrical Repairs Ltd., Birmingham. He is senior official of the company which is the largest repair organization in Great Britain. He is responsible for the company's business in central England and controls two works in Birmingham. The work carried out consists of the repair, overhaul, servicing, and alteration for changed conditions of all types of electrical plant, rotating and static. This

**Joseph Ashmore**

**Raymond S. Daniels**



**Leslie Greenwood**

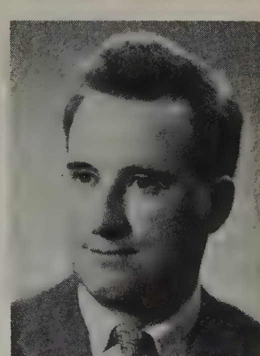
includes all sizes up to about 30,000 kva, turbo alternators, transformers and voltage up to 33 kv, rectifiers, electronic equipment, and switchgear. In addition, electrical contracting work is done on power and lighting installations, including the design and equipment of industrial consumers' substations. Mr. Ashmore is a member of the Institutions of Electrical Engineers and Mechanical Engineers of Great Britain, and a fellow of the Illuminating Engineering Society.

**Raymond S. Daniels** (AM '07, M '21, Member for Life), electrical engineering consultant, The California Oregon Power Company, Medford, Oreg., has been transferred to the grade of Fellow in the AIEE "for engineering leadership and technical competence in analyzing long-range requirements of large electric power systems and in the design and execution of plant expansion projects." Mr. Daniels was born on December 6, 1879, in New York and was graduated in 1905 from the University of California with a bachelor of science degree in electrical engineering. Entering the employ of the Washington Water Power Company, Spokane, in 1905 as a draftsman, he subsequently rose to the positions of assistant foreman in 1906, foreman in 1908, and electrical engineer in 1913. In the last-named capacity he had charge of design for powerhouses and substations. In 1921 Mr. Daniels became associated with the California Oregon Power Company as an electrical engineer and until June 1929 he was in charge of design of transmission lines, substations, and distribution problems. In the following period, until July 1952, acting in the capacity of chief electrical engineer, he was in charge of system planning, substation design, transmission and distribution design and he handled all electrical problems in connection with the operation of an electrical utility system. As Electrical Engineering Consultant since 1952 he acts in a consulting and advisory capacity on transmission and generation problems.

**Leslie Greenwood** (AM '28, M '36), chief electrical designer (machines), Crompton-Parkinson, Ltd., Chelmsford, Essex, England, has been transferred to the grade of Fellow in the AIEE "for contributions in the field of alternating-current and direct-current machine design, exemplified both by actual practice as well as by authorship of technical literature." Mr. Greenwood was born in Hebden Bridge, Yorkshire, England, September 13, 1903, and attended Halifax Technical College. After serving as a-c design engineer with the Electric Construction Company, Wolverhampton, England, he joined the Harland Engineering Company, Alloa, Scotland, as chief designer (electrical machines) in 1936. He was responsible for the design of synchronous motors up to 6.6 kv, engine-driven alternators up to 6.6 kv, geared turbine-driven alternators up to 2,500 kva, 1,000 rpm, and large high-speed synchronous motors for driving generators for paper making plant. He also designed induction motors and frequency changers and d-c motors and generators with a maximum output of about 850 kw. In 1946 he joined Crompton-Parkinson, Ltd., Chelmsford, Essex, as chief electrical designer (machines). His present responsibilities include the design of synchronous machines, induction motors, and d-c motors and generators. This has included design of engine-type alternators up to 6.6 kv, auto-synchronous motors and synchronous condensers, all types of induction motors from 250 horsepower to 1,500 horsepower, battery vehicle motors, arc-welding generators, fan-cooled and screen-protected machines, ground-starting generators for aircraft, motor-generator sets for the film industry, and self-regulating alternators from 5 to 150 kva both dual-voltage and dual-frequency. Mr. Greenwood is the author of "D-C Machine Design" which is used as a work of reference by designers and schools of engineering. Mr. Greenwood is a member of the Institutions of Electrical Engineers and Mechanical Engineers of Great Britain.

# AIEE PERSONALITIES.....

**P. A. Abetti,** (AM '49), Power Transformer Engineering Division, General Electric Company, Pittsfield, Mass., has been selected as the nation's outstanding young electrical engineer for 1953 by Eta Kappa Nu Association. Mr. Abetti was chosen for "his original approach to power transformer design through the creation of unique electromagnetic models and his exceptional civic and cultural attainments." Mr. Abetti will receive his award at a dinner during the Winter General Meeting of the AIEE. Born February 7, 1921, in Florence, Italy, Mr. Abetti came to the United States in 1946. In Italy he studied at the University of Florence, the Polytechnical Institute of Turin, and the University of Pisa, receiving a doctor of engineering degree in 1946 from Pisa. He continued his studies in the United States at the Illinois Institute of Technology where he received a master of science degree in 1948 and subsequently received a doctor of philosophy degree in 1953. Mr. Abetti joined the General Electric Company in 1948 and is employed in the advance and development engineering subsection of power transformer engineering. In addition to his work at the company, he also teaches graduate courses at Rensselaer Polytechnic Institute, Troy, N. Y., and Massachusetts Institute of Technology, Cambridge. Mr. Abetti received the Coffin Award from General Electric in 1953 for his work in electromagnetic models of power transformers. He is a member of Eta Kappa Nu, Tau Beta Pi, Sigma Xi, and is serving on the AIEE Committee on Basic Sciences (1953–54).



**P. A. Abetti**

**A. G. Kegel** (AM '48), development engineering department, Air-Arm Division, Westinghouse Electric Corporation, Baltimore, Md., has received honorable mention in the Eta Kappa Nu Association competition for the outstanding young electrical engineer. Mr. Kegel was cited for "his distinguished contributions to the design of autopilots and fire control systems and his unselfish work for his church and the youth of his community." A native of Chicago, Ill., Mr. Kegal was graduated from Northwestern University with a bachelor of science degree in 1947. His college studies had been interrupted from 1944 to 1946 by a tour of duty in the U. S. Navy during which time he was engaged in maintenance and installation of electronic equipment. He joined Westinghouse upon graduation in 1947 and received his masters degree in 1949. Mr. Kegel's first assignment with the company was in the Special Products Development Division in Pittsburgh, Pa. He was transferred to the Baltimore Air-Arm Division when it was organized in 1951, and was made a project engineer assigned to the advanced control technique group. He has played an important part in the development of automatic pilots and fire control systems used in

guided missiles and in radar for jet aircraft. Mr. Kegel is a member of Tau Beta Pi, the Institute of Radio Engineers, the National Society of Professional Engineers, and is serving on the AIEE Committee on Feedback Control Systems (1950–54).

**M. J. Kelly** (M '26, F '31), president, Bell Telephone Laboratories, Inc., New York, N. Y., has been selected to receive the Industrial Research Institute Medal for 1954. The medal is awarded for "outstanding accomplishment in leadership in or management of industrial research which contributed broadly to the development of industry or the public welfare." Dr. Kelly began his Bell System career as a research physicist with the Western Electric Company in 1918, and became associated with Bell Telephone Laboratories when it was incorporated in 1925. He became president in 1951. Beginning in 1938, he was increasingly active in research and development for the military and was awarded the Presidential Certificate of Merit for his war efforts. He also has had various assignments in Washington, D.C., of a public service nature. Dr. Kelly was graduated in 1914 from the Missouri School of Mines and Metallurgy with a bachelor of science degree, and has received subsequent degrees from the Universities of Kentucky and Chicago. He is a fellow of the American Physical Society, Acoustical Society of America, and the Institute of Radio Engineers, and a member of the National Academy of Sciences, the American Philosophical Society, Tau Beta Pi, Eta Kappa Nu, and Sigma Xi. Dr. Kelly has served on the AIEE Committees on Communications (1934–37); Standards (1934–39, 1941–43); Basic Sciences (1937–46); Lamme Medal (1940–43); Research (1940–51, Chairman, 1949–51); Award of Institute Prizes (1949–51); and Technical Program (1949–50).

**A. W. Montgomery** (M '46), joint general manager, Standard Telephones and Cables Ltd., London, England; **W. F. Bailey** (AM '34), engineer, Hazeltine Corporation, Little Neck, N. Y.; **D. H. Clewell** (M '49), director, Field Research Laboratories, Magnolia Petroleum Company, Dallas, Tex.; **R. B. Colton** (F '46), major general, retired, United States Army, Washington, D. C.; **C. A. Culver** (F '22, Member for Life), senior physicist, Southwest Research Institute, San Antonio, Tex.; **M. A. Edwards** (M '40, F '47), manager of engineering, X-ray department, General Electric Company, Milwaukee, Wis.; **E. P. Felch** (M '39), technical staff, Bell Telephone Laboratories, Inc., Murray Hill, N. J.; **A. W. Friend** (AM '33, M '39), director of engineering and development, Magnetic Metals Company, Camden, N. J.; **N. L. Harvey** (AM '35, M '50), chief engineer, Sylvania Electric Products, Inc., Buffalo, N. Y.; **D. A. Quarles** (AM '23, F '41), Assistant Secretary of Defense for Research and Development, Department of Defense, Washington, D. C.; **W. H. Radford** (AM '33, M '48), professor of electrical communications, Massachusetts Institute of Technology, Cambridge; **W. L. Webb** (AM '49, M '52), manager, missile section, Bendix Products Division, Bendix Aviation Corporation, Mishawaka, Ind.; and **K. R. Wendt** (M '52), manager, advanced development, Sylvania Electric Products, Inc., Buffalo, N. Y., have been named fellows of the Institute of Radio Engineers. The grade of fellow is the highest membership grade offered by the institute and is bestowed only by invitation on those who have made outstanding contributions to radio engineering or allied fields.

**M. A. Hyde** (AM '27, M '45), advisory engineer, industry engineering department, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been awarded the Westinghouse Order of Merit for "his contributions to industrial electrification, engineering literature, patent art, and the training of young engineers; for his broad knowledge and understanding of industry problems; and for his outstanding engineering achievements in the electrification of petroleum pipe lines." Mr. Hyde was active in the electrification of the "Big Inch" and "Little Big Inch" pipe lines. A native of Owego, N. Y., Mr. Hyde was graduated from Marietta College in 1919 with a bachelor of arts degree and in 1922 received his bachelor of science degree in electrical engineering from Case Institute of Technology. He joined Westinghouse that same year and after serving on an apprentice course for a year, he was assigned to the general engineering department where he worked on the application of electric equipment in many different industries. In 1935 he was transferred to the industrial sales department where he worked with the commercial phases of industrial electrification. He returned to the newly organized industry engineering department in 1938, working on applications in the petroleum and chemical industries. Since 1940 he has devoted himself chiefly to the development and application of pipe-line electrification. He became a senior engineer in 1946 and in March 1953 was made an advisory engineer. Mr. Hyde is a member of the American Petroleum Institute and has served on the AIEE Committee on Chemical, Electrochemical and Electrothermal Applications (1947-54).

**H. V. Barr** (AM '44), manager, Tidd Plant, Ohio Power Company, Brilliant, has been appointed manager of the Clifty Creek generating plant of the Indiana-Kentucky Electric Corporation, Madison, Ind. Mr. Barr's 35 years in power plants all have been spent with the American Gas and Electric System. He started as an oiler at Windsor Plant, near Wheeling, W. Va., shortly after it began operation in 1917. He was transferred to Philo Plant near Zanesville, Ohio, when it commenced operation in 1924 and was shift operating engineer there until 1940. Meanwhile, he also had spent a brief period at Twin Branch Plant, Mishawaka, Ind., while that station was being placed in service in 1925. Mr. Barr spent 1940 with the Mechanical Engineering Division of the American Gas and Electric Service Corporation, New York, N. Y., then returned to Philo as head of its results department. He was promoted to assistant manager of the Tidd Plant in Brilliant in 1947, shortly after it began operation. He has been manager of the plant since September 1948. Windsor, Philo, and Tidd Plants are stations of the Ohio Power Company and Twin Branch Plant is a station of the Indiana and Michigan Electric Company, both subsidiary operating electrical utilities of the American Gas and Electric Company.

**M. B. Wyman** (AM '30, F '42), manager, district engineering and service department, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been named manager of the engineering and service department of the Apparatus Division, and **H. C. Coleman** (AM '18, F '48), manager, industry engineering department, has been named assistant manager of the new department. Born in Yarmouth, Nova Scotia, Canada, Mr. Wyman joined Westinghouse at East Pittsburgh in 1923. After service in the general engineering department, he was named engineering manager for the Southwestern District, at St. Louis, Mo., in 1931. He returned to East Pittsburgh in 1938 to become manager of the district engineering and service department. He received the Westinghouse Order of Merit in 1943. A graduate of Dalhousie University and Nova Scotia Technical College, Mr. Wyman holds a bachelor of arts degree and a bachelor of science degree in electrical engineering. He is a member of the American Society of Military Engineers and the Engineers Society of Western Pennsylvania and has served on the AIEE Committee on Membership (1939–42). Mr. Coleman is a native of Ashtabula, Ohio, and joined Westinghouse in 1916 following graduation from Ohio State University. During World War I, he directed special Westinghouse projects connected with electrification of submarines and assisted in sea trials of turbine electric propulsion on the battleships *Tennessee* and *Colorado*. Mr. Coleman advanced the application of electric couplings for ship propulsion, as well as diesel propulsion for ships. In 1942 he received the Westinghouse Order of Merit. He is also the recipient of official commendation from the United States Navy for "outstanding accomplishments" during World War II. Mr. Coleman is a member of the Society of Naval Architects and Marine Engineers and the American Society of Naval Engineers and has served on the following AIEE committees: Marine Transportation (1927–54, Chairman, 1933–35); Technical Program (1933–35, 1948–50); General Applications Co-ordinating (1948–50, Chairman, 1948–50); Planning and Co-ordination (1948–50); Award of Institute Prizes (1948–50); Technical Advisory (1950–51); and Standards (1951–54).

**H. P. Steele** (AM '44), executive vice-president, Benjamin Electric Manufacturing Company Des Plaines, Ill., has been elected a vice-president of the National Electrical Manufacturers Association. Elected to serve on the Board of Governors of the association for 1 year were **J. F. Lincoln** (AM '08, F '39, Member for Life), president, the Lincoln Electric Company, Cleveland, Ohio; **C. F. Mullenbach** (M '48), president, Mullenbach Electrical Manufacturing Company, Los Angeles, Calif.; and **J. S. Thompson** (AM '14, F '38, Member for Life), president, Pacific Electric Manufacturing Corporation, San Francisco, Calif. **W. H. Burleson** (M '31), manager, power utilities department, Ohio Brass Company, Mansfield, was elected to the board for the term ending in

1955 to fill a position left vacant by a resignation. **J. E. Bixler** (AM '35, M '53), president, Duncan Electric Manufacturing Company, Lafayette, Ind., and **J. J. Mullen, Jr.** (AM '39, M '48), president, Moloney Electric Company, St. Louis, Mo., were elected to the board for a 3-year term. **C. W. Higbee** (M '37), manager, electrical wire and cable department, United States Rubber Company, New York, N. Y., was re-elected to the board for the term ending in 1956.

**C. P. West** (AM '20, F '46), engineering manager, Switchgear Division, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been named assistant to the manager of the division, and **A. A. Johnson** (AM '32, F '50) manager of electric utility engineering, industry engineering department, has been named manager of the Switchgear Division's engineering department. A native of Cleveland, Ohio, Mr. West joined Westinghouse in 1926 after service with the Cleveland Railways Company as superintendent of electrical construction. At East Pittsburgh, he successively held the positions of section engineer, manager of switchboard engineering, and division engineering manager. He attended Case Institute of Technology and during World War I served in the United States Navy. He has served on the AIEE Committee on Switchgear (1950–54). Mr. Johnson began his career with Westinghouse in 1941 after 11 years of engineering work for the Consolidated Edison Company of New York. He served as central station engineer in the Westinghouse industry engineering department and was appointed manager of electric utility engineering for the department in 1949. Mr. Johnson is a native of Mineral, Va., and was graduated from the University of Virginia with a bachelor of science degree in electrical engineering in 1930. He taught electrical engineering and mathematics at Pratt Institute, Brooklyn, N. Y., and has published numerous technical papers on electrical transmission and distribution. Mr. Johnson has served on the following AIEE committees: Protective Devices (1947–54, Chairman, 1953–54); System Engineering (1947–50); Transformers (1947–54); Liaison Representative on Standards Committee (1951–54); Sections (1952–54); and Power Division (1953–54).

**M. E. Lord** (AM '51), manager, fractional horsepower motor department, General Electric Company, Fort Wayne, Ind., retired recently after 45 years service with the company. With General Electric since 1908, Mr. Lord became department manager in 1947 when the company established an integrated operating unit form of management to provide for expanded production. Prior to that, he served as Fort Wayne works manager for 8 years. A native of Brooklyn, N. Y., Mr. Lord attended night classes at Newark Evening Technical School, now Newark College of Engineering. In 1908 he accepted a job with the General Electric Newark (N. J.) Lamp Works. By 1916 he was assistant plant superintendent. A few years later he moved to the company's Edison Lamp Works, Harrison, N. J., where he was on the production manager's staff as assistant in charge of manufacturing. In 1929 he moved to Schenectady, N. Y., as a member of the vice-president's manufacturing staff. Six months later Mr. Lord was appointed secretary of the company's manufacturing committee. He completed a 4-year assignment as co-ordinator of manufacturing activities for General Electric refrigerator plants in Erie, Pa., Schenectady, and Fort Wayne before moving to Fort Wayne in 1939 as works manager.

**R. J. Bibbero** (M '53), head of the servomechanisms department, Guided Missiles Division, Republic Aviation Corporation, New York, N. Y., has been named chief development engineer, Hillyer Instrument Company, New York, N. Y. Previously Mr. Bibbero has been employed as servomechanisms group leader and project engineer, Bell Aircraft Corporation; staff engineer with the Research Laboratory, Linde Air Products Company; research engineer of the Pacific Manifolding Book Division of the Moore Business Forms Company, Inc.; and as chemical engineer, Spreckles Sugar Company, Woodland, Calif. During World War II he served as electronics and ordnance officer with the United States Navy. Mr. Bibbero was graduated in chemistry from the University of California in 1938 and in chemical engineering from the University of Michigan. In 1948 he received the master of science degree in electrical engineering from the University of Buffalo. Mr. Bibbero is a senior member of the Institute of Radio Engineers and of the American Chemical Society and a member of the American Association for the advancement of Science.

**J. S. Brown** (AM '23, F '50), electrical engineer, Duquesne Light Company, Pittsburgh, Pa., has been appointed chief engineer of the company and will be in charge of the engineering department. After receiving his early education in Menominee, Mich., where he was born, Mr. Brown enlisted in the United States Navy in 1918, where he was assigned to experimental and development work in radio. After his discharge from the Navy in 1919, he spent some time in radio engineering. One of his assignments was in connection with the construction of the transatlantic receiving station at Lakewood, N. J. From 1920 until he joined Duquesne Light Company in 1937, Mr. Brown held several positions with various companies which necessitated travel throughout the country, as well as assignments outside the United States. In 1945 he was named electrical station engineer in charge of all Duquesne Light Company power stations, substations, and electrical engineering and design. He was named electrical engineer in 1951. Mr. Brown is a member of the Pennsylvania Electric Association and the American Standards Association and has served on the AIEE Committee on Switchgear (1947–54).

**M. A. Honnell** (M '45), professor of electrical engineering in charge of communications and electronics, Georgia Institute of Technology, Atlanta, has been elected vice-president and chief engineer, Measurements Corporation, Boonton, N. J. Mr. Honnell graduated from Georgia Institute of Technology in 1934 with bachelor of science degree of electrical engineering and received his masters degree in 1940 and the electrical engineer degree in 1945 from the same institution. During World War II, in addition to his duties as associate professor, he conducted the Ultrahigh-Frequency Techniques Course of the Engineering Science Management War Training program and was supervisor of the pre-radar school for Signal Corps employees. Mr. Honnell also has done consulting engineering work. He is a senior member of the Institute of Radio Engineers, and a member of the American Society for Engineering Education, Tau Beta Pi, Eta Kappa Nu, and Phi Kappa Phi. He has served on the AIEE Committee on Television and Aural Broadcasting Systems (1950–51).

**J. H. Watkins** (M '50), electrical engineer, Miller Hofft, Inc., Richmond, Va., has been appointed sales manager of transformers and allied products, Kuhlman Electric Company, Bay City, Mich. Mr. Watkins is a graduate electrical engineer of the University of Virginia. Beginning as a student engineer with the General Electric Company, Mr. Watkins joined the transformer engineering department in Pittsfield, Mass., in 1936. In 1940 he was transferred to the Oakland, Calif., plant and by 1942 was section head of the transformer engineering division. In 1945 he was named manager of production and personnel for J. W. Beardsley's Sons, Newark, N. J. He joined the consulting engineering firm of Slaughter, Saville and Blackburn, Inc., Richmond, Va. in 1947 and was made vice-president of this company a year later. Since 1950 he has been proposal and contract engineer for Miller Hofft, Inc.

**W. W. Brown** (M '26), Electronics Division engineer, General Electric Company, Syracuse, N. Y., has been presented with the Exceptional Service Award by the Military Air Transport Service at Andrews Air Force Base, Md., one of the highest awards given to civilians during peacetime. Since 1951 Mr. Brown has directed an Air Force low-frequency radio project designed to increase the efficiency and scope of the North East Air Command's network of communications.

**L. E. Blackwell, Jr.** (AM '53), sales application engineer, Reliance Electric and Engineering Company, Cleveland, Ohio, has been appointed to the Charlotte, N. C., sales office. Mr. Blackwell joined the Reliance company in 1952 following his graduation from Duke University.

**E. W. Michaels** (AM '50), supervisor of the control system design group, Consolidated Vultee Aircraft Corporation, Pomona, Calif., has been appointed supervisor of the advance development group for the Packard-Bell Company, Los Angeles, Calif. The group is engaged in research and development of color television and the possible applications of transistors and printed circuitry to radio and television receivers. Dr. Michaels previously had been a member of the research staffs of the Rauland Corporation and Cook Research Laboratories, Chicago, Ill. He is a member of the Institute of Radio Engineers and holds a professional engineers license in the state of California.

**H. L. Van Valkenburg** (AM '05, F '39, Member for Life), vice-president and chief engineer, Industrial Controller Division, Square D Company, Milwaukee, Wis., recently celebrated his 40th anniversary as an executive of Square D, and his 58th year as an engineer since he began as an apprentice in 1895. Mr. Van Valkenburg's first experience was as a student engineer with the Westinghouse Electric and Manufacturing Company (now the Westinghouse Electric Corporation) in East Pittsburgh, Pa. His work for Square D began when the company was known as the Industrial Controller Company. In 1929, when the Industrial Controller Company merged with Square D, he became a vice-president and later was designated chief engineer and vice-president in charge of the Milwaukee plant.

**G. M. Anderson** (AM '49), Atomic Power Division, Westinghouse Electric Corporation, Pittsburgh, Pa., has been appointed head of the engineering development group at the Edison Laboratory, Thomas A. Edison, Inc., West Orange, N. J. After obtaining his doctor of philosophy degree from Carnegie Institute of Technology, Pittsburgh, in 1948, Dr. Anderson stayed on for 3 years as an assistant professor of electrical engineering. From 1951 until his present appointment, he worked on the development of the atomic reactor for submarine propulsion at the Westinghouse Atomic Power Division. He is a member of the Institute of Radio Engineers.

**A. G. Darling** (M '44), industrial power engineer, General Electric Company, Schenectady, N. Y., retired recently after 42 years of service with the company. Mr. Darling, a native of Canada, joined General Electric in 1911 on the Test Program after the completion of his graduate training in electrical engineering at Cornell University. Since the middle 1920's he has concentrated on the industrial power engineering field, and was responsible for the engineering on the electrical generating station at the Ford Motor Company in Detroit, Mich., and on a large electronic frequency converter at the Carnegie Illinois Steel Company, Pittsburgh, Pa. He is a registered professional engineer in New York State.

**S. H. Webster** (M '44), assistant to the president, Aviation Engineering Division, Avien-Knickerbocker, Inc., Woodside, N. Y., has been named manager of the Northeastern District, Jack and Heintz, Inc., with headquarters in New York, N. Y. A graduate of Northeastern University, he previously had been manager of aircraft sales engineering of Eclipse Pioneer Division, Bendix Aviation Corporation, Teterboro, N. J. He is a member of the Society of Automotive Engineers, Institute of Aeronautical Sciences, and the Aircraft Electrical Society, and has served on the AIEE Committee on Air Transportation (1948–52).

**Perry Dudley, Jr.** (AM '53), Reliance Electric and Engineering Company, Cleveland, Ohio, has been transferred to the Los Angeles, Calif., office. Mr. Dudley joined the company in 1952, following his graduation from Purdue University.

# OBITUARY • • • •

**Robert Andrews Millikan** (M '22, HM '33), professor emeritus of physics and vice-president, Board of Trustees, California Institute of Technology, Pasadena, died December 19, 1953. Dr. Millikan had received the Nobel Prize in physics in 1923 for his work in isolating and measuring the electron, and for his researches on the photoelectric effect. Dr. Millikan was born in Morrison, Ill., March 22, 1868. He received his bachelor of arts degree from Oberlin College in 1891 and his masters degree in physics from the same school in 1893. He received the award of a fellowship at Columbia University, where the doctor of philosophy degree in physics was conferred on him in 1895. Then he studied for 2 years in Berlin and Goettingen Universities in Germany. He was assistant in physics, University of Chicago, Ill., 1896–97; an associate in 1897–99; an instructor in 1899–1902; assistant professor in 1902–07; associate professor, 1907–10; and professor from 1910 until 1921. He had served as as director of the Norman Bridge Laboratory of Physics and as chairman of the executive council of the California Institute of Technology from 1921 to 1945. During World War II his scientific work on rocket and jet propulsion development won him the Presidential Medal of Merit. Technically retired as head of the California Institute of Technology in 1946, he had continued to make contributions to cosmic-ray studies. These studies made by Dr. Millikan aroused a universal interest. He started his researches on the phenomena in 1915. His theory on cosmic rays was that they originated from the interstellar spaces and were the "birth-cries" of new atoms of heavier elements such as iron, oxygen, and silicon, being created from the lighter ones, such as hydrogen and helium. In addition to the Nobel Prize, Dr. Millikan had received the Edison Medal from the AIEE in 1922, the Hughes Medal of the Royal Society of Great Britain, 1923; Faraday Medal of the London Chemical Society, 1924; Gold Medal of The American Society of Mechanical Engineers, 1926; the Franklin Medal of the Franklin Institute, 1937; and many others. He held honorary degrees from most of the leading universities and colleges in this country. He was a commander of the French Legion of Honor and a member of leading scientific socities in the United States and in Europe. He was the author of 18 books and a large number of contributions to scientific publications. He had served the AIEE on the Committees on the Edison Medal (1923–28, 1934–40) and Electrophysics (1923–30).

**Howard Wallace Leitch** (AM '98, M '13, Member for Life), retired, Consolidated Edison Company of New York, Inc., New York, N. Y., died November 2, 1953. Mr. Leitch had retired as a vice-president of the company in 1941. He was born in Brooklyn, N. Y., October 31, 1875, and graduated from Brooklyn Polytechnic Institute in 1894 with a bachelor of science degree in electrical engineering and an electrical engineer degree in 1895. In 1895 he joined New York Edison and was assigned to the operating department. In 1902 he went as an a-c operator to the Waterside Station and by 1907 was assistant electrical superintendent there. Six years later he was chosen to be electrical superintendent of power plants of the United Electric Light and Power Company, New York, to get its Sherman Creek Station under way. Later the Hell Gate Plant was built under his supervision. When the United and New York Edison Companies were consolidated in 1935, Mr. Leitch became associate chief operating engineer. He became vice-president in charge of electrical operations in 1938. Mr. Leitch was active in The American Society of Mechanical Engineers and the National Electric Light Association and had served on the following AIEE committees: Safety Codes (1927–29); Power Generation (1929–36, Chairman, 1933–35); and Technical Program (1933–35).

**Charles Joseph Huber** (AM '13, Member for Life), development engineer, Sanderson and Porter, New York, N. Y., died December 22, 1953. Mr. Huber was born in Attica, Ind., August 24, 1886, and graduated from Purdue University in 1908 with a bachelor of science degree in electrical engineering. He was a physicist with the National Bureau of Standards, Washington, D. C., from 1908 to 1913 and an electrical and process engineer for the Larkin Company of Buffalo, N. Y., from 1913 to 1920. During World War I he served as a captain with the Army's Ordnance Department. He was chief engineer for the United Drug Company of Boston, Mass., from 1920 to 1923. As Far Eastern manager for the United States Testing Company, Inc., Hoboken, N. J., from 1923 to 1927, Mr. Huber completed several missions to China to improve that nation's natural silk industry. He was director of research for Cheney Brothers, Manchester, Conn., from 1927 to 1931, and then he returned to U.S. Testing as vice-president. He served as development engineer for Johnson and Johnson, New Brunswick, N. J., from 1943 to 1946. During the last 7 years, as development engineer with Sanderson and Porter, Mr. Huber made many trips overseas as consultant to foreign governments. He was a member of the American Society for Testing Materials.

**Paul Spencer Clapp** (AM '18), retired, New York, N. Y., died December 5, 1953. Mr. Clapp was a former electrical engineer and utilities executive. He was born in Toledo, Iowa, July 29, 1890, and graduated from Iowa State College in 1913 with a bachelor of science degree in electrical engineering. After graduation he became an engineer for the Western Electric Company, New York, N. Y., where he did telephone research. In World War I he served overseas with the Signal Corps and held the rank of captain at his discharge. After the war he remained abroad to take a post with the American Relief Administration under Herbert Hoover, and on his return became special assistant to Mr. Hoover, who was then Secretary of Commerce. He left the Commerce Department in 1926 to become managing director of the National Electric Light Association. He was vice-president of the Columbia (Ohio) Gas and Electric Corporation from

1932 to 1942, and then became vice-president of both the Ohio Fuel Gas Company and the Cincinnati (Ohio) Gas and Electric Company. In 1945 he also became vice-president of the Columbia Engineering Company.

**George A. Matthews** (AM '40, M '42), retired, inspection and equipment engineer, the Detroit (Mich.) Edison Company, died November 24, 1953. Mr. Matthews was born in Clinton, Mass., December 4, 1885. He started his electrical engineering career with the Connecticut Lighting and Railway Company in Waterbury. He also worked for the Rockland Light and Power Company, Nyack, N. Y., and Western Coal and Mining Company, Jenny Lind, Ark., before joining Detroit Edison in 1916. He was responsible for numerous improvements in high-voltage transformers and switchgear and had 20 U.S. patents and a number of patent applications in his name, as well as several Canadian patents and applications. In 1941, Mr. Matthews received a national prize award from the AIEE for a study entitled "Power Arc-Over on Overhead Distribution Lines, and Newly Developed Equipment for Protection Against Conductor Burndowns From That Cause." He was a pioneer in the field of equipment described in that paper. Mr. Matthews was a member of the Engineering Society of Detroit.

**Chester Irving Hall** (AM '10, M '17, F '20, Member for Life), consulting engineer, General Electric Company, Schenectady, N. Y., died December 7, 1953. Mr. Hall was born in Topeka, Kans., in 1883, and was graduated from the University of Illinois in 1910 with a bachelor of science degree in electrical engineering. After a year with Commonwealth Edison Company, Chicago, Ill., Mr. Hall became general manager of the Chicago Electric Meter Company and the Minerallac Company, also of Chicago. These companies joined General Electric 2 years later. In 1928 Mr. Hall left General Electric to found and become president of the Hall Electric Heating Company in Philadelphia, Pa., but he dissolved the company in 1934 and returned to General Electric at Schenectady. He retired in February 1953. He held the greatest number of patents among active company employees when he retired, 139 American patents and 600 foreign. Mr. Hall had received the Charles A. Coffin Award from the company and had served on the AIEE committee on Research (1922–25).

**Charles H. Bunch** (AM '16, M '32), chairman of the board and treasurer, Acme Electric Corporation, Cuba, N. Y., died December 11, 1953. Mr. Bunch was born in Garrettsville, Ohio, July 4, 1892, and graduated from Ohio University in 1915. He started his engineering career in Cleveland, Ohio, with Electric Products Company and in 1917 became one of the founders of Acme Electric. The company was organized and operated in Cleveland until 1937, when it moved its main operations to Cuba, N. Y. Mr. Bunch held various positions with the company from chief engineer, sales director, president, and 2 years ago was elected board chairman. He was also one of the founders and an officer in Acme Electric Supply Company of Montreal, Que., Canada, and Acme Electric Corporation, Ltd., Toronto, Ont., Canada. Mr. Bunch was a member of the Illuminating Engineering Society.

**Foster A. Hinshaw** (AM '35), member of the technical staff, Bell Telephone Laboratories, Inc., Murray Hill, N. J., died October 28, 1953. Mr. Hinshaw was born in Lyons, Kans., September 13, 1904, and graduated from Kansas State College in 1926 with a bachelor of science degree in electrical engineering. Mr. Hinshaw joined the staff of the Bell Telephone Laboratories upon graduation and for 16 years engaged in development of telephone systems and apparatus. In World War II he served in the Signal Corps and was discharged in 1946 with the rank of captain. He then returned to Bell's technical staff and in 1952 was assigned to defense work. He was lost at sea October 28, 1953, while engaged in a secret Navy project.

**Charles Justus Koch** (AM '26, M '45), manager of engineering, medium induction motor department, General Electric Company, Schenectady, N. Y., died November 14, 1953. Mr. Koch was born in Baltimore, Md., January 10, 1904. He was one of the first to graduate in the co-operative course in electrical engineering organized by Massachusetts Institute of Technology and General Electric, receiving his bachelors degree in 1923 and his masters degree in 1924. He joined General Electric in 1924. In 1939 he became assistant engineer for the induction motor departments and in 1947 was appointed manager. Mr. Koch had served on the AIEE Committees on Electric Machinery (1946–47) and Rotating Machinery (1947–48).

# MEMBERSHIP • • •

## Recommended for Transfer

The Board of Examiners at its meeting of December 17, 1953, recommended the following members for transfer to the grade of membership indicated. Any objections to these transfers should be filed at once with the Secretary of the Institute. A statement of valid reasons for such objections, signed by a member, must be furnished and will be treated as confidential.

### To Grade of Member

Allen, T. E., engineer, General Electric Co., Schenectady, N. Y.
Amey, W. G., supervisory research engineer, Leeds & Northrup Co., Philadelphia, Pa.
Badgett, E. D., plant engineer, Granite City Steel Co., Granite City, Ill.
Banky, J. N., field engineer, Allis-Chalmers Mfg. Co., Chicago, Ill.
Barnes, H. C., relay section head, American Gas & Electric Service Corp., New York, N. Y.
Barstow, J. P., power engineer, Consumers Power Co., Manistee, Mich.
Blanchette, V. G., electrical engineer, General Electric Co., Richland, Wash.
Bloom, W. E., electrical engineer, U. S. Army Corps of Engineers, Sacramento, Calif.
Bottum, E. L., principal electrical engineer, Jackson & Moreland, Boston, Mass.
Bowen, D. L., production design engineer, Northrop Aircraft, Inc., Hawthorne, Calif.
Brewer, R. D., electrical engineering section supervisor, Ford Motor Co., Dearborn, Mich.
Carlberg, N. E., radio engineer, Civil Aeronautics Administration, Seattle, Wash.
Chakraverty, N. C., principal, Central Training Institute for Instructors, Koni, Bilaspur, India
Clark, C. S., sales engineer, General Electric Co., Wichita, Kans.
Cole, C. C., equipment engineer, Duquesne Light Co., Pittsburgh, Pa.
Cooney, J. L., Jr., staff engineer, Corning Glass Works, Corning, N. Y.
Crampton, H. E., assistant vice-president, Michigan Bell Telephone Co., Detroit, Mich.
Danko, J. T., consulting electrical engineer, 1010 Keystone Bldg., Pittsburgh, Pa.
Duce, T. E., owner, Thomas E. Duce Associates, Consulting Engineers, Corpus Christi, Tex.
Dunaiski, R. M., design engineer, General Electric Co., Schenectady, N. Y.
Geary, B. H., development engineering supervisor, Canadian General Electric Co., Toronto, Ont., Canada
Gue, W. M., electrical supervisor, Westinghouse Electric Corp., Seattle, Wash.
Hart, J. A., supervisor, Allison Div., General Motors Corp., Indianapolis, Ind.
Hoffman, W. E., electrical designer, E. I. du Pont de Nemours & Co., Wilmington, Del.
Huskison, E. J., production superintendent, Arizona Public Service Co., Phoenix, Ariz.
Iyer, A. V., electrical engineer in charge, The Negapatam Electric Supply Co., Ltd., Negapatam, South India
Jester, L. T., application engineer, General Electric Co. Boston, Mass.
Jones, S. J., electrical engineer, Aluminum Co. of America, Alcoa, Tenn.
Kaplan, M. N., assistant professor, Drexel Institute of Technology, Philadelphia, Pa.
Keefer, H. D., power superintendent, Aluminum Company of America, Port Lavaca, Tex.
Krammes, D. C., head, electrical laboratory, Hoover Co., North Canton, Ohio
Lagerstrom, J. E., assistant professor of electrical engineering, Iowa State College, Ames, Iowa
Lemmond, C. Q., supervisor, General Electric Co., Schenectady, N. Y.
Lent, H. A., electrical engineer, General Electric Co., West Lynn, Mass.
Luhnow, R. B., Jr., senior engineer, Burns & McDonnell Engineering Co., Kansas City, Mo.
Lull, A. D., electrical engineer, Tennessee Valley Authority, Chattanooga, Tenn.
Lynn, R. G., electrical engineer, American Hoist & Derrick Co., St. Paul, Minn.
Marshall, T. H., Jr., manager, electric utility dept., General Electric Co., Baltimore, Md.
Morales, D. J., consulting engineer, Box 2394, Caracas, Venezuela
Nelson, L. E., owner & manager, Nelson Instrument Co., Evanston, Ill.
Pearson, H. T., engineer, Commonwealth Edison Co., Chicago, Ill.
Peters, H. E., supervising engineer, The Bell Telephone Co. of Pennsylvania, Pittsburgh, Pa.
Raymond, R. G., engineer, Illinois Bell Telephone Co., Chicago, Ill.
Ross, E. G., electrical engineer, The Austin Co., Chicago, Ill.
Scheneman, E. E., design engineer, Westinghouse Electric Corp., Baltimore, Md.
Schulhof, J., electrical design engineer, Sanderson & Porter, Engineers, 52 William St., New York, N. Y.
Schwartz, G. J., vice-president, Doelcam Corporation, Boston, Mass.
Schwartz, R. F., associate, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Pa.
Shepherd, J. F., electronics engineer, Norfolk Naval Shipyard, Portsmouth, Va.
Steiner, L. S., superintendent of maintenance, The Timken Roller Bearing Co., Canton, Ohio
Summers, F. R., switchgear engineer, Westinghouse Electric Corp., St. Louis, Mo.
Viola, A. G., branch manager, Wagner Electric Corp., Kansas City, Mo.
Wilson, C. A., plant engineer, Roots-Connersville Blower Corp., Connersville, Ind.

53 to grade of Member

## Applications for Election

Applications for admission or re-election to Institute membership, in the grade of Fellow and Member, have been received from the following candidates, and any number objecting to election should supply a signed statement to the Secretary before February 25, 1954, or April 25, 1954, if the applicant resides outside of the United States, Canada, or Mexico.

### To Grade of Member

Clark, D. E., Automatic Elec. Co., Chicago, Ill.
Huch, O. F., (re-election), Stewart A. Jellett Co., Philadelphia, Pa.
Linder, C. H., General Elec. Co., New York, N. Y.
Moore, J. H., Leeds & Northrup Co., Philadelphia, Pa
Ollendoff, F., Hebrew Institute of Technology, Haifa, Israel
Parker, B. E., Consolidated Vultee Aircraft Corp., San Diego, Calif.
Swantz, F. W., Dept. of Officer Communication School U.S.A.F., Scott Air Force Base, Ill.

7 to grade of Member

## VOLSCAN Automatic Electronic System Controls Landing of Incoming Planes

VOLSCAN, developed in secrecy over the past 5 years, is an automatic electronic system for bringing aircraft into a base at precise intervals of 30 seconds. In thousands of flight tests with many types of jet and propeller-driven airplanes during the past year, the system has proved to be the long-sought means of eliminating the "stacking up" of planes over busy military and civilian airports. Airport traffic controllers at most bases today often are forced to delay aircraft for long periods of time because manual systems can control, at the most, 40 aircraft per hour.

**Scientists watch "Skiatron," the plotting board which follows radar tracks of aircraft under control of VOLSCAN. The path of each aircraft approaching an airport can be traced on the Skiatron**

Known officially as "Air Traffic Control Central, *AN/GSN-3*," the system is not a radar set; rather it is a combination of electronic, tracking, and computing units which are capable of automatic control of all planes approaching an airport.

Despite the complex portions of the apparatus, the system, according to scientists, is "basically simple," and will cost approximately $100,000 per air base, which is but a small fraction of the cost of a single modern aircraft.

Looking at the exterior of the site, there is little to indicate the important work which the Air Force is doing there.

Outside only a bright yellow truck sits on a hill with a large rotating radar antenna above it. This radar is similar to the *AN/CPN-18* which is now the standard radar equipment at many air bases.

However, several hundred yards away in an underground concrete bunker, which was used for the control of big harbor defense guns in World War II, are two rooms. One room, illuminated only by dim red lights, contains the main control console and radar scope, as well as a large flat radar display for recording the performance of aircraft under control. The other room contains the various electronic devices which make up VOLSCAN's electronic brain.

VOLSCAN is capable of controlling an entire area from one site. Thus, in a demonstration near Boston, Mass., aircraft were "fed into" Norwood Airport, Beverly Airport, the Weymouth Naval Air Station, and Grave's Lighthouse. The last-named was used to simulate approaches to Logan Airport without interfering with Logan's commercial traffic.

When the incoming planes were about 60 miles from Boston, they were seen by VOLSCAN's "eyes"—the radar in the bright yellow truck—and their radar echoes appeared on the circular screen of the radar scope in the bunker. The screen gives a maplike picture of the entire control area and the planes appear as tiny yellow dots moving across it.

Meanwhile the planes have told VOLSCAN's "ears," the traffic operator, for which airport they are bound and she points a VOLSCAN Light Gun at the aircraft's signal on the scope. Instantly, a small square of yellow light called a tracking gate surrounds the radar's blip. Each plane scheduled to land is enclosed by one of these gates.

As each plane's signal moves, the little tracking gate follows it, sorting out its data from that of all other planes, and memorizing its position and velocity. These gates are produced by automatic tracking-while-scanning devices called "Antracs,"

**External view of the AN/CPN-18 radar truck and antenna. This apparatus with the special antenna screen modified for the project was developed by scientists at the Air Force Cambridge Research Center. The truck at right is now in use at Fort Dawes, Mass. The truck at left is used to make the system mobile. An entire VOLSCAN system can be placed in these two vehicles**

### Future Meetings of Other Societies

**American Management Association.** General Management Conference. March 9–12, 1954, Fairmont Hotel, San Francisco, Calif.

**Association of Iron and Steel Engineers.** West Coast Meeting. February 15–17, 1954, Hotel Statler, Los Angeles, Calif.

**Audio Engineering Society.** 1954 Audio Fair. February 4–6, 1954, Alexandria Hotel, Los Angeles, Calif.

**Conference on Marine Corrosion Problems.** February 8–9, 1954, University of California, Berkeley, Calif.

**Institute of Radio Engineers.** National Convention. March 22–25, 1954, Waldorf-Astoria Hotel and Kingsbridge Armory, New York, N. Y.

**Institute of Radio Engineers.** 6th Annual Conference and Electronics Show. February 4–6, 1954, Hotel Tulsa, Tulsa, Okla.

**Instrument Society of America.** 9th Annual Regional Conference. February 4, 1954, Hotel Statler, New York, N. Y.

**National Association of Corrosion Engineers.** 10th Annual Conference and Exhibition. March 15–19, 1954, Kansas City, Mo.

**National Association of Purchasing Agents, Public Utility Buyers' Group.** Mid-Winter Conference. February 15–16, 1954, Lord Baltimore Hotel, Baltimore, Md.

**National Electrical Manufacturers Association.** March 8–11, 1954, Edgewater Beach Hotel, Chicago, Ill.

**Society of Automotive Engineers.** National Passenger Car, Body, and Materials Meeting. March 2–4, 1954, Hotel Statler, Detroit, Mich.

**Society of Automotive Engineers.** National Production Meeting and Forum. March 29–31, 1954, The Drake, Chicago, Ill.

**Society of Women Engineers.** National Convention. March 5–7, 1954, Washington, D. C.

**Southeastern Electric Exchange.** 21st Annual Conference. March 22–24, 1954, Boca Raton Hotel, Boca Raton, Fla.

**The American Society of Mechanical Engineers.** International Meeting. March 10–12, 1954, Del Prado Hotel, Mexico, D. F., Mexico

**Traffic operator mans the VOLSCAN light gun at the console in the control room**

which are VOLSCAN's memory cells. Even if the radar echo fades out, they will continue to move in accordance with their memory of the aircraft's past performance, thus predicting where the aircraft will appear when the fade has passed.

Once the gate is tracking the aircraft's signal, the traffic operator pushes a button which starts VOLSCAN's cortex operating. This device, the reasoning and calculating section of VOLSCAN's brain, is called "Datac." An electronic traffic manager considers the plane's relationship to the airport and to other inbound aircraft and automatically selects a schedule which will permit it to arrive as early as possible without conflicting with other planes.

Safe arrival is the first consideration, and speed of arrival, the second. Once it has selected the schedule Datac continuously calculates control orders for the aircraft consisting of headings to fly, altitudes, airspeed, and discrete instructions, such as, slow down, lower landing gear, etc.

Datac does not confine the aircraft to an artificial "railroad-track" type of path in the sky. Instead it uses the plane's ability to maneuver and achieves its precise timing by changing the aircraft's heading so that it will fly a path whose length is just enough to bring it to the final approach within 9 seconds of its scheduled arrival.

These control orders from Datac can be remoted and displayed in the aircraft or they can be fed directly into the automatic pilot. In the latter case, Datac actually would be flying the plane from the ground. Such remoting will take place over the standard data link.

Since data link is not yet available in all aircraft, VOLSCAN now uses relay men, who merely read Datac's orders over a voice radio channel to the pilot. In this case, no apparatus is required in the aircraft except that which it normally carries.

VOLSCAN can direct the aircraft until it is 2 miles from the runway and lined up with it in heading and altitude. At this point in the great majority of weather situations the pilot can land visually. If the weather is unusually bad, the last 2 miles can be made on GCA (Ground Control Approach) or ILS (Instrument Landing System.)

Project VOLSCAN has been under the direction of Benjamin F. Greene of Canton, Mass. Herbert Knight of Arlington is the assistant project engineer.

# Film Optical Sensing Device Processes Information for Input to Computers

An instrument that provides rapid, automatic processing of information into a form suitable for direct input to large-scale electronic computers has been developed by M. L. Greenough, H. D. Cook, M. Martens, and associates of the National Bureau of Standards (NBS) at the request of the Bureau of the Census. Named FOSDIC (Film Optical Sensing Device for Input to Computers), the machine reads marks on microfilmed copies of documents that have been marked with an ordinary pencil or pen, and then processes the information into electric pulses which are recorded on magnetic tape for direct input to an electronic computer such as the Census Univac. FOSDIC is designed to reduce the work that now is involved in converting written records into a medium acceptable as input by data-processing machines. This is particularly true since FOSDIC allows considerable freedom in design of the documents and does not require the use of any special writing instrument.

It is anticipated that ultimately the use of this machine will reduce appreciably the massive amount of paper-work entailed in summarizing Census information on the entire population. Although designed for census operations, FOSDIC may be generally applied to the processing of other types of information that must be handled in large quantities.

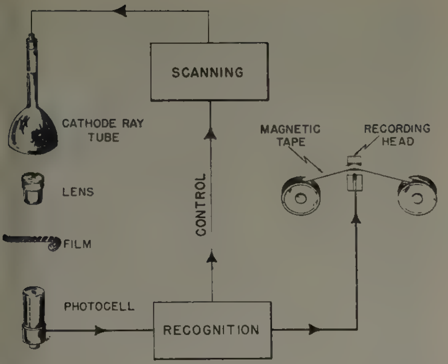
The method of mark sensing used by FOSDIC is the detection of specific blacked-in areas or ovals in a large field of possible answers arranged on a sheet of paper. A "yes-no" answer is given two ovals while a numerical answer is supplied with a vertical column of ten ovals for each decade. The desired information is indicated by the locations of the marks. It then becomes the task of the sensing equipment to tell the computer precisely which ovals the enumerator has marked to signify his available information. Since FOSDIC senses the presence or absence of a mark by optical means, readings are not affected by the electrical conductivity of the mark or the paper, or by any mechanical indentation of the paper due to lack of stiffness. In practice, the interrogating agency need not supply special pencils since any common marking device is satisfactory.

The scanning process is carried out on a frame-by-frame basis. Each frame is a microfilmed picture of one side of a sheet which may be as large as 14 by 16 inches. The film is placed in an optical assembly between a cathode-ray tube with a moving spot that scans the image and a photocell that produces a varying electric signal from the light beam that has passed through the film. The current maximum capacity is about 2,800 marks per sheet, since this is the present limit of adequate legibility of marks on the document. An individual film is scanned in 0.5 to 0.9 second. Allowing for film change and other functions, the total time per frame is about $1^1/_4$ seconds. The average information rate is approximately 2,000 binary digits or 250 decimal digits per second.

The chief problem in the design of mark sensing equipment lies in the developing of a method to locate the individual ovals with the necessary degree of precision. In a mechanically registered system, such as that used for detecting conducting-pencil marks, the pickup heads are located at fixed distances from the edge of the document. The assumptions are made that the edges are well-defined and that the paper stock has dimensional stability. In FOSDIC, however, the paper edge is replaced by a printed index mark below each column. When located by the scanning process, the index mark furnishes an exact guide to the column position. Column height, or distance from top to bottom oval, is not as critical as in a mechanical system since each answer is searched for over an area several times the size of the oval. Thus, with these degrees of freedom over ordinary scanning methods, the use of multiline documents on ordinary bond paper stock is feasible. The amount of information per document is considerably increased over punched cards.

FOSDIC's electronic equipment is composed of many separate and distinct circuit groups, each designed to carry out a unique function. For example, the index recognition circuit determines when the scanning beam is at the top edge of a solid mark between 0.24 and 0.36 inch high. To make this decision, however, it must have been informed previously that a number of other

**Film is placed in the optical assembly between a cathode-ray tube with a moving spot that scans the image and a photocell that produces a varying signal from the light beam that has passed through the film**




**Flow diagram of FOSDIC. The scanning control directs the beam of the cathode-ray tube to the appropriate area on the microfilm. The information is picked up by the photocell and converted into coded-pulse form and recorded on magnetic tape**

conditions have been met. Among these conditions are: (1) a frame to be scanned must be present, (2) the degree of tilt of the document must have been measured, (3) the scanning beam must be over the page, and (4) the apparent index mark must be genuine and not a thin vertical line crossed obliquely by the scanning beam. The reading program begins immediately after recognition of the index mark occurs.

All information is read out in serial order in blocks of 720 characters and occupies four of the eight channels on the magnetic tape. A character consists of four digits; thus each block can contain more than 2,800 digits. Each document, either single or double sided, is included in one block and the remainder of the 720 characters is made up of dummy pulses. To assure that the order is not upset by the loss of a column somewhere on the page, FOSDIC makes a column count on each document. If a column is missed for any reason, such as a film defect, a characteristic record is made on the tape informing the computer that information in this block is not trustworthy. Information contained on such documents then is restored to the tape by a supplementary correction process.

Although a complete check is maintained on the information so that it cannot get out of order, this check is not as thorough nor as elaborate as a check on individual answers. Determination of over-all system reliability was left to special evaluation tests in conjunction with the Univac computer. The instrument itself shows near-perfect response when operated under good marking and filming conditions. Tests with the Census computer indicate that film defects are the largest source of the few mistakes. For example, holes in the emulsion which happen to lie at an answer area leave FOSDIC with no choice but to declare an apparent mark. Although adequate statistics on the probability of these errors are not yet established, preliminary results for standard commercial processing appear to show less than one error in 100,000 ovals. If further tests indicate probable errors as infrequent as this, then it can be concluded that the transcription process through FOSDIC, including filming, does not appreciably add to other sources of error in the enumeration process.

## First Surface-Barrier Transistor Developed for Military and Civilian Uses

Development of a new type of transistor which out-performs all transistors currently in use for both military and civilian equipment, was announced recently by Philco Corporation.

"The new 'Surface-Barrier' transistor," said Leslie J. Woods, vice president-director, Philco research and engineering, "operates at high frequencies and with low power consumption—requirements which have limited the use of transistors up to this time to hearing aids and devices where stability is relatively unimportant."

The "Surface-Barrier" transistor was announced to the Franklin Institute at a meeting attended by members of the institute, the Institute of Radio Engineers, representatives of the Department of Defense, and officials from other companies engaged in electronics research and production.

"The Surface-Barrier transistor is of unique construction and unprecedented performance," Mr. Woods said. "It has operating characteristics which make possible its use at frequencies 10 to 100 times as high as obtainable with the older alloy junction transistors.

"The new unit operates with such economy of power consumption that for the first time a portable military communications receiver operating on very-high-frequency channels can be powered solely by two flashlight cells. The receiver can be made as small as a pack of cigarettes and has an operating life of many weeks," he said.

Behind the Surface-Barrier transistor is a new method of processing germanium which gives promise of transistor mass production.

"This new method exhibits the highest mechanical precision yet attained in machining germanium," Mr. Woods said. "The process consists of directing two tiny streams of liquid indium salt at opposite sides of a tiny slab of germanium. Electric current is passed through the streams so as to etch away the germanium. This process continues until the two streams almost drill through the slab. When the germanium has been etched down to a few ten thousandths of an inch in thickness, the current is suddenly reversed. The etching is thus instantly arrested and indium is immediately electroplated on the germanium by the reversed current flow to form electrodes on both sides. The resultant assembly, with wires attached to the two electrodes, is hermetically sealed in a metal container.

"Methods have been developed which arrest the etching so precisely that the remaining thickness of germanium is controlled to a tolerance of ten millionths of an inch, or less than the wavelength of visible light. Such precision has not been possible in producing earlier types of transistors."

Mr. Woods said Surface-Barrier transistors operate reliably in frequency ranges up to 70 megacycles, which include an important military very-high-frequency communication band from 20 to 58 megacycles.

"We anticipate application of the Surface-Barrier transistor to the important field of electronic computers," David B. Smith, Philco vice-president of research, said. "In many military and commercial applications, we need computers which operate at very high speeds and perform large numbers of arithmetical operations. Computers using large numbers of vacuum tubes require many kilowatts of power—too much power. The Surface-Barrier transistor will reduce the power requirements of computers from many kilowatts to a few watts, and will make similar savings in weight.

"We believe the Surface-Barrier transistor is the key to opening up the possibility of transistorizing all manner of devices in the field of communications. For the first time, we have a transistor which meets the opportunities for these devices in the electronic field. We believe it fulfills the hopes and ambitions heretofore held out but not realized for these devices."

In addition to demonstrating the miniature military receiver, Mr. Smith showed a possible application of the new type of transistor as a beacon for sea rescue. It consisted of a tiny oscillator which obtained all the power necessary for operation from a little salt water. Therefore, Mr. Smith pointed out, the unit can be permanently built into a lifeboat or liferaft, and as soon as it comes in contact with sea water, it will send out a signal on which search airplanes can "home." No attention or action of any kind is required by anyone in the lifeboat.

In announcing the Surface-Barrier transistor, Philco acknowledged with appreciation co-operation received from the Bureau of Ships, Department of the Navy, which partially sponsored research work leading to its development.

### World Power Conference to Hold Sectional Meeting in Brazil

The 1954 Sectional Meeting of the World Power Conference will be held in Rio de Janeiro, Brazil, July 25 to August 8, 1954.

The first week of the meeting is to be devoted to technical sessions followed by a rather extensive study tour during the second week by bus and air lines. Because of the difficulties in transport, the Brazilian National Committee has decided to organize one single tour which will be divided into two separate parties scheduled to make the journey in reverse directions with a common point of contact at Sao Paulo, Brazil.

The group will inspect steel mills and thermal and hydroelectric power plants.

The United States National Committee of the conference has been allocated 11 papers for the technical sessions.

# Electronic Fish-Finder Locates Fish, Indicates Depth and Underwater Hazards

An engineering team from the Radiomarine Corporation of America has just returned from several experimental trips during which a revolutionary new electronic fish-finder was tested. Reports prove that the fish-finder, Fischlupe, locates fish, spots underwater hazards that hang fishing nets, aids navigation, and functions as an underwater depth indicator.

Echograph, a new recording depth sounder, was tested also with excellent results. Both Fischlupe and Echograph are but several pieces of apparatus in a complete line of depth-sounding equipment being distributed by Radiomarine which was developed by Electroacustic G.m.b.H. of Kiel, Germany.

Fischlupe, which means "Fish-Lens," is one of the newest and most modern cathode-ray-type depth sounders and is especially designed to function as an electronic fish-finder. The greatest advantage of the cathode-ray tube in its function as a fish-finder is that it provides a clear visual indication of fish reflections. It is so sensitive, it detects and shows whether the reflection on the scope is being made by a single fish or a school.

The cathode-ray tube measures depth and displays echoes downward through the water on the same basic principle that a radar scope measures distance through the air. Thus, when the powerful supersonic signals are transmitted downward, the echoes from the sea bed, schools of fish, rocks, wrecks, or plankton, are returned and presented on the cathode-ray tube.

A school of fish appears as short horizontal traces on the cathode-ray tube. The depth at which the school appears can be read directly from a calibrated scale. The school then can be magnified to give larger horizontal traces. This is done by merely turning a switch. The face of the tube will then show an 8-fathom vertical area. This or any other 8-fathom vertical area, may be moved up and down and accurate measurements made of the depth and density of the school.

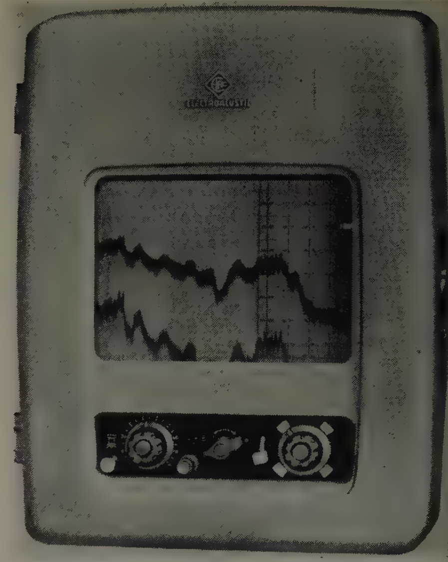
The basic operating switch is the Range Control, which is a 2-position switch marked Fixed and Variable. In the Fixed position the cathode-ray tube covers the normal maximum range of 280 fathoms (see Figure 1). In the Variable position any 8-fathom depth may be selected between the vessel's bottom and the sea bed whereby it is magnified, as illustrated in Figures 2 and 3.

The depth scale is controlled by a knob and may be adjusted to any depth setting to a maximum of 320 fathoms. The sensitivity control adjusts the sensitivity in Fischlupe so that the picture on the scope may be set to the desired intensity. The dimmer switch is a rheostat to adjust the illumination of lights behind the front panel for various scales and controls.

Although Fischlupe can be used for normal depth sounding its principal function is fish indicating. To obtain a permanent record of the bottom contour and underwater conditions, Echograph, an 8-range recording depth sounder, can be installed as an independent unit or as a supplement to Fischlupe. The same transmitting and receiving transducers, pulse generator, and motor generator (if required) are used for operating both devices.

Essentially Echograph is used for navigation, survey work, and fishing. Operating on the same basic echo-sounding principles as Fischlupe, Echograph instantaneously reproduces underwater conditions on an 8-inch-wide electrosensitive, dry recording paper. The size and depth of fish-shoals, plankton, rocks, and wrecks under a vessel are shown on the chart.

Only a minimum of experience is needed to interpret the scope presentation. The size of the haul can be estimated as can the direction of the center of the shoal where fish are usually thickest. Fish swimming close to the sea bed also are clearly shown on Fischlupe.



Echograph, a recording depth sounder

With Fischlupe the length of fishing time can be reduced; unprofitable "sets" can be avoided; and nets can be hauled in at the most profitable time. Indications of the sea bed are readily shown on Fischlupe, making it ideal for navigation and survey work; and servicing has been reduced to a minimum.

Echograph is an invaluable aid to navigators in any weather. Its highly sensitive, magnostrictive transducers quickly pick up all return echoes. The eight ranges provided by Echograph give fishermen the best possible picture of underwater conditions saving them many hours in locating shoals and setting their drift nets, midwater nets, or trawl nets. The speed at which the 8-inch-wide recording paper moves can be regulated, and its governor-controlled

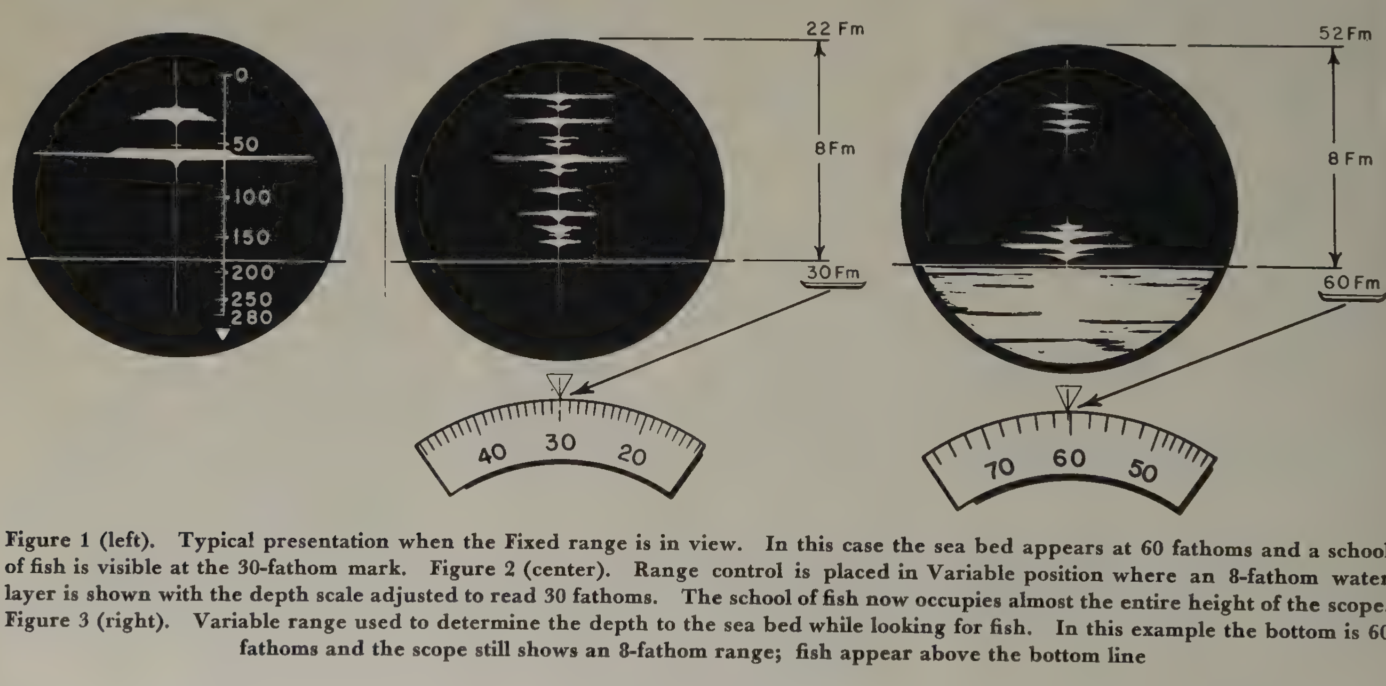



**Figure 1 (left). Typical presentation when the Fixed range is in view. In this case the sea bed appears at 60 fathoms and a school of fish is visible at the 30-fathom mark. Figure 2 (center). Range control is placed in Variable position where an 8-fathom water layer is shown with the depth scale adjusted to read 30 fathoms. The school of fish now occupies almost the entire height of the scope. Figure 3 (right). Variable range used to determine the depth to the sea bed while looking for fish. In this example the bottom is 60 fathoms and the scope still shows an 8-fathom range; fish appear above the bottom line**

**Fischlupe installation on fishing boat**

motor assures accurate depth sounding.

Echoes from plankton and mud can be cut down to a point where they will not interfere with the clear indications of echoes from objects near the surface. The dry recording paper is unaffected by temperature and humidity changes; and a large window is provided for observation of the marking stylus. Provisions also are made for automatic marking of the recording chart at 5-minute intervals, in addition to providing for manual marking.

## Dictating Machine Employs Magnetic Belt for Recording

The first dictation machine to employ an endless magnetic belt as the recording medium, in combination with advanced electronic features, has been introduced to the dictation equipment field by Peirce Dictation Systems, Incorporated. Representing the furthest development in modern dictation equipment, the new Peirce Magnetic Dictation machine is completely electronic and is the result of 3 years of intensive research by Peirce and by the Armour Research Foundation of Chicago.

The basic feature of the new Peirce Magnetic Dictation is the magnetic recording of the dictator's words on an endless belt, which faithfully reproduces every word and inflection of the dictator's voice and is manufactured by Minnesota Mining and Manufacturing Company. It can be used and reused an unlimited number of times; it also can be mailed, or filed for future reference. The belt has a 15-minute limit, the time cycle found most practical for office use.

"Error-free" dictation has been built into the new Magnetic Dictation machine. This feature allows the dictator to change his mind with ease and speed. By simply backing up the belt to the point where the correction would begin and redictating right over what was originally dictated, the correction is made and there is no need for marking a correction slip. There is also no possibility of the transcriber not catching the correction. Every operating control—dictate, listen, back-up—is centered on the hand microphone for complete ease and convenience of operation.

The microphone has exclusive built-in sound level which transmits to the recording medium either "whisper" or "boom" dictators with bell-like clarity. The microphone also serves as the play-back medium for listening to what has been dictated.

The new Peirce Magnetic Dictation equipment can be used as a combination dictator and transcriber or a separate transcribing unit is available. A feature of the transcribing unit is the automatic backspacer, which always lets the transcribing secretary know where she left off. This feature, which back spaces approximately two words when the operating foot is depressed, allows the transcriber to hear the last two or three words she has typed, giving her complete continuity when transcribing what has been dictated.

## First Telephone Cable System to Be Constructed Across Atlantic

The Long Lines Department of the American Telephone and Telegraph Company has announced plans to construct the first telephone cable system across the Atlantic Ocean. It will be by far the longest underseas voice cable in the world and the first laid at depths found in mid-ocean.

The announcement stated that an agreement had been signed, for construction of the cable, by the American Telephone and Telegraph Company, the British Post Office, which organization provides telephone service in Great Britain, and the Canadian Overseas Telecommunication Corporation, which furnishes overseas communications for Canada. It will be owned jointly by these three organizations.

Developmental and research work on such a cable has been going on for 25 years. The project will take 3 years to complete and will cost $35,000,000.

This cable will mean greater reliability in transatlantic telephone conversations and greatly expanded facilities. It will provide physical telephone connection between the United States and the British Isles to supplement radio circuits now in use, and will have three times present circuit capacity.

The submarine telephone cable system will contain a group of telephone circuits between New York, N. Y., and London, England, and another group between Montreal, Quebec, Canada, and London, England. At the gateway cities the circuits will connect with the telephone systems of the respective countries.

The transatlantic portion of the system, with its many vacuum tube repeaters, will be 2,000 nautical miles in length and will be laid in depths up to 3 miles on the ocean floor between Scotland and Newfoundland, Canada. It will then connect with another submarine cable extending 300 miles westward to Nova Scotia, Canada. From there, a 350-mile overland microwave radio-relay system will be built to carry the transatlantic circuits to the United States border where connections will be made with the Bell System network.

Development of the technical design for the deep sea section of the cable project has been under way in the Bell Telephone Laboratories for several years. Research by British telephone engineers has produced the design for the Newfoundland–Nova Scotia section of the submarine cable. As a result, the project will make use of the experience of both the Bell System and the British Post Office.

The announcement also covered many of the technical problems faced by telephone engineers in providing a transatlantic telephone cable. For example, amplifiers had to be developed which could be laid successfully from a cable ship, and which would operate satisfactorily without attention under the great pressures existing on the Atlantic floor. Such devices were developed several years ago and have undergone successful trial between Key West, Fla., and Havana, Cuba, since 1950. There will be over 100 underwater repeaters on the transatlantic segment of the proposed system. The vacuum tubes used in these amplifiers have been under development for years and have withstood both laboratory and underwater operating tests of the severest kind. The voice currents will travel along coaxial conductors which will be insulated by a solid layer of polyethylene. Power to operate the vacuum tubes on the ocean bed will be fed in from both ends of the cable along the same coaxial conductor. The cable will be protected by a wrapping of copper foil, over which there will be a heavy cover of jute and steel wires.

## Aerial Electrometer Will Study Atmospheric Electricity

A project is being conducted by the Air Force's Air Research and Development Command to shed some light on the tremendous power—upwards of 100,000 volts—that exists between our earth and the upper stratosphere, a problem pertinent to long-range communications today and one that may even affect future interplanetary flight.

To assist in collecting data on this unexplained electric current that flows from high aloft to the earth, scientists are sending up, by balloons, a supersensitive electronic instrument at the Holloman Air Development Center, Alamogordo, N. Mex. Designed and developed by Minneapolis-Honeywell Regulator Company for the Air Force, the new "aerial electrometer" will be carried by balloons as high as 100,000 feet. Until now, scientists have been able to collect data on atmospheric electricity from measuring instruments carried by airplanes only up to 35,000 feet.

This upper stratosphere project is a part of a continuing study being made of the terrestrial electrical field existing between the earth and the ionosphere which begins between 60 and 80 miles above earth. Scientists of Air Research and Development Command's Air Force Cambridge (Mass.) Research Center, where the large mass of information will be analyzed for an over-all picture, predict that data obtained from the phase of the program now underway will be invaluable in understanding the current of 1,800 amperes constantly flowing toward the earth. Science has been trying to discover the source of this tremendous amount of current for over 50 years.

The sensitive, electronic device to be used

in the experiment was designed and developed in the Nuclear Engineering Laboratory of Honeywell's Industrial Division. It weighs only $6^1/_2$ pounds, is the size of a portable radio, and is powered by batteries and packed with subminiaturized electronic parts. An aluminum case with special insulation is expected to minimize the problem of solar radiation and low temperatures found at high altitudes. Honeywell engineers explain that at stratospheric altitudes, although outside air temperature may be as low as 80 degrees below zero, the sun's rays could generate enough heat inside the instrument to melt some of the parts.

According to John Werme, Honeywell research and development engineer on the project, the instrument is so sensitive that it will measure minute flows of electric current—as low as ten millionth of an ampere, or 1,000,000 ions per second. An idea of the device's sensitivity is obtained from the fact that it would take about one million billion ions to get enough energy to light a flashlight momentarily, he said.

Carried aloft by large plastic, free flying balloons, the instrument instantaneously radios back to a ground recording station the electrical conductivity, air temperature, and air pressure. By interpreting the temperature and pressure readings, the scientists will be able to determine accurately the altitude of the instrument, thus obtaining a record of the variation of the electrical conductivity with the altitude. Upon reaching maximum height, the balloon is mechanically broken and the apparatus parachuted to the ground. Data are taken for the descent, too. The research project is expected to conclude sometime next year.

## New Equipment Developed for Demonstrating Fluid Mechanics

A comprehensive equipment which will expand college mechanical and aeronautical engineering laboratory facilities in the field of fluid mechanics has been announced by the General Electric Company.

The packaged device is an adjustable-blade multistage axial-flow fan with a cradled d-c dynamometer. It is designed to help give a better understanding of the fundamentals of energy transfer and fluid flow encountered in axial-flow turbomachinery.

Experiments performed with the unit can be applicable equally to the basic fluid mechanics of the multistage axial-flow compressor used in gas turbines and other applications. It also may be used in dynamometer absorption demonstrations as a prime mover driving other test machines, and as a low-pressure air supply of substantial volume for many types of laboratory test work.

The basic unit consists of an axial-flow fan direct-connected to and mounted on a common bedplate with a $7^1/_2$-horsepower d-c cradled dynamometer. Dynamometer scale readings and speed provide for direct measurement of horsepower required by the fan for all test conditions.

The fan has a maximum speed rating of 3,000 rpm, and the dynamometer, equipped with a field rheostat, 4,000 rpm. However, as shipped from the factory, the field rheostat has a stop limiting the speed to approximately 3,000 rpm. Minimum speed of the dynamometer is limited to approximately 500 rpm because of inadequate ventilation and cooling at lower speeds.

Variable voltage control for the dynamometer is provided by including a speed variator utilizing 220-volt 60-cycle 3-phase current. This power supply unit provides continuously adjustable armature and field control permitting selection of any desired speed setting within the horsepower and speed rating of the dynamometer.

The fan assembly is made up of two stages with 24 identical rotor blades and 37 identical stator blades in each stage. All blades can be rotated 360 degrees and a protractor-type template is furnished for accuracy in adjusting blade angles.

Rotor blades are individually cast of aluminum alloy. Stator blades are made of sheet steel formed to the proper shape.

## Portable Transceiver, Megaphone Announced by Stewart-Warner

Two new devices for short- or intermediate-range communication—a battery-powered megaphone for distances up to $^1/_4$ mile and a radio transceiver for 2-way communication—have been announced by Stewart-Warner Electric, the television, radio, and electronics division of Stewart-Warner Corporation.

The radio transceiver, called the "Portafone," carries Federal Communications Commission (FCC) Class *B* raido-telephone-type approval, and operates in the citizens' radio band at a fixed frequency of 465 megacycles. The citizens' band is that segment of the ultrahigh-frequency spectrum which lies between the Land Mobile Radio Services and ultrahigh-frequency television channels.

The Portafone may be operated as a portable radio station when used with a battery pack, or as a fixed central radio station by connecting it to a special power pack designed to plug into any 115-volt 60-cycle a-c electric outlet. It may be operated in an automobile by plugging a special adapter into the cigarette lighter socket of the car's instrument panel.

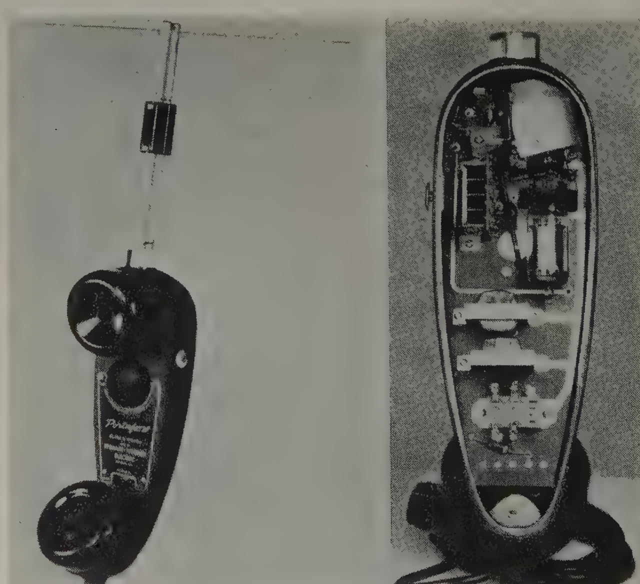
According to Colonel John R. Howland, commercial sales manager of Stewart-Warner

**Chief Deputy Fire Marshall Albert Peterson of Chicago, Ill., Fire Department uses power megaphone during fire. (Inset) View of megaphone with microphone removed. Unit is powered by six flashlight batteries**

Electric, Portafone is the only such device to have received FCC-type approval. It is available now for purchase and use by private citizens as well as commercial, governmental agency, or industrial users, he said.

The Portafone requires an FCC station license, but not an operator's license, Colonel Howland stated. It is sold in pairs, each of which combines a transmitter and receiver in one instrument similar in appearance to a telephone handset. Weight is 28 ounces.

The power megaphone is a hand-held device, which embodies a microphone, a powerful speaker, and batteries in a single unit for amplifying the voice. It weighs 5 pounds, 5 ounces, is operated with six flashlight batteries, and is made ready for instant operation by pressing a trigger switch in the handle. It provides quick, clear projection of the human voice up to $^1/_4$ mile, and the flashlight batteries which power it will last for as long as 3 weeks of normal intermittent use for 8 hours a day.



**(Left) Portafone is new system of short-range communication approved by the FCC as Class B telephone transmitter - receiver. Units will be sold in pairs or multiples. (Right) Portafone super - regenerative circuit printed on ceramics base. Glow-lamp is contained in antenna base to indicate battery reserve**

## Miniature Electrostatic Generator Uses Printed-Circuit Techniques

A miniature electrostatic source of high voltage for use with radiation survey instruments has been developed by the National Bureau of Standards (NBS). The device is an adaptation of the work of Holtz and Wommelsdorf* on influence-type generators of conventional size, but it uses modern printed-circuit and miniaturization techniques. Operation of this type of generator depends on the ability of one charged body to induce a charge on another body close by. The device is one result of a program sponsored by the Navy Bureau of Ships for the investigation and application of techniques adaptable to low-cost mass production of radiation survey instruments.

Many instruments for the detection and measurement of nuclear radiation require high-voltage sources of low current to supply polarization potentials for ionization chambers. Conventionally this voltage is obtained from miniature high-voltage batteries used directly or in combination with capacitors charged in parallel and then connected in series, from a vacuum-tube oscillator in combination with a high-ratio transformer and rectifier, or from a vibrator power supply. The NBS generator that is designed to replace these is simpler to fabricate, is potentially less expensive, has fewer components, and avoids the use of special batteries that may be difficult to obtain.

The alpha survey meter using the air proportional counter provides an opportunity for application of this electrostatic source. The probe requires 2,000 volts at a current of $10^{-12}$ to $10^{-14}$ ampere, which can be obtained conveniently from a storage capacitor recharged periodically by the new generator.

The generator consists basically of a stator of two field plate conductors, and a rotor with a number of pairs of conducting sectors. Printed-circuit techniques are used to apply the conducting areas to the flat insulating plates of the rotor and stator. Several sets of brushes transfer electric charges between the components of the system and the storage capacitor. The attached driving system enables the rotor to be driven at speeds as high as 6,000 rpm by a reciprocating drive mechanism operated by an external lever. Although simpler drive systems were devised, the reciprocating type was chosen for its convenience, small size, and the ease with which it can be adapted to a hermetically sealed generator.

One problem in the development of the NBS generator was the devising of a method to establish a unique polarity of output voltage. The randomness of the initial charge distribution which determines the output polarity can be overcome in several ways. One method relies on the use of a dielectric material which retains charge for a long period of time. Another scheme utilizes the triboelectric potential of different brush materials and dielectrics to establish the initial charge distribution. A third method, used in the NBS instrument, requires the use of a small external bias voltage to precharge the generator. The biasing method was adopted because it is the most reliable and because the polarizing potential is already available in the associated electronic equipment.

Experiments indicate that size places no particular limitation on the successful performance of the printed-circuit generators. Practical units as small as $1^5/_8$ inch in diameter have been constructed. As the size decreases, however, the output current decreases correspondingly; the disadvantage here is that a longer time is required to charge the storage capacitor. The spacing of the elements having maximum potential stress determines the output voltage.

Experience with the NBS electrostatic generator shows that a 0.02-microfarad capacitor can be charged to 2 kv in about 15 seconds. In use in the radiation survey instrument, the capacitor needs to be recharged only occasionally to make up a leakage loss of about 100 volts. This can be replenished by the generator in a single operation of the lever on the driving mechanism.

* U. S. patent number *1,071,196*, August 26, 1913.

## New Recorder Improves Processing of Sugar

An electronic recording instrument which for the first time automatically and continuously computes sugar supersaturation, a critical step in the sugar refining process, was announced recently by the Industrial Division of Minneapolis-Honeywell Regulator Company.

Developed after some 5 years of field research, the new recording instrument accurately measures the degree of supersaturation by determining the boiling temperature of the sugar solution, the absolute pressure of gases and vapors under which the solution is boiling, and the purity of the solution. Supersaturation, engineers explain, is that point at which the highly concentrated syrup, after boiling, contains more sugar in solution than could be dissolved by water at a given temperature. In sugar making, it is at this point that crystallization of sugar is started by introducing crystals.

To obtain maximum production and a uniformly grained sugar, the degree of supersaturation must be measured precisely to determine when to "seed" and pan with crystals. If supersaturation is allowed to go too high, additional unwanted crystals are formed and must later be dissolved—a process that also dissolves some of the desired crystals.

Conventional methods of determining the degree of supersaturation ranged from reliance on the skill of the old-time "sugar boiler," to the use of several instruments necessitating time-consuming computations. Occasionally crystallization proceeded so rapidly that the whole mass solidified and had to be chopped apart and remelted.

The newly developed electronic recording instrument—a single-pen circular-chart recorder—automatically and continuously provides accurate measurement of supersaturation to permit control of the seeding process.

Field tests have shown that the sugar produced under these controlled conditions is more uniform, of higher quality, and requires less reprocessing.

## Third Convention of UPADI to Be Held in Brazil in August

The Pan-American Federation of Engineering Associations (UPADI) will hold its Third Convention in Sao Paulo, Brazil, August 3 to 13, 1954. Western Hemisphere engineers chose Sao Paulo for the meeting in honor of the 400th Anniversary of the founding of the city. The time was selected so that engineers might attend both the UPADI Convention and the World Power Conference.

UPADI was organized in 1951 in Havana, Cuba, after a preliminary meeting in Rio de Janeiro, Brazil, in 1949. The Second Convention in 1952 in New Orleans, La., coincided with the 100th Anniversary of the American Society of Civil Engineers and permitted Latin delegates to participate in the observance.

At the Sao Paulo meeting the organization will continue its work on developing standards of practice and professional ethics. Through its Committee on Technical Studies, it will discuss methods of exchanging information on subjects of common interest. But its most important objective will be the establishment of good relations and understanding among engineers of the Americas.

Host for the convention will be the Brazilian Federation of Engineering Associations of which F. Saturnino de Brito, Jr., is president. At the Ionvention a new slate of officers will be elected to succeed President Luis Giannettassio of Uruguay who has guided UPADI successfully in this initial period.

Opportunities will be provided for tours to sites of interest. A large delegation from the United States and Canada is expected to attend.

The AIEE is represented in UPADI through Engineers Joint Council. A member of the Institute may make use of UPADI services. Anyone interested in learning more about UPADI or the Sao Paulo convention may secure information by filling out the coupon below and sending it to UPADI, Box 40, Midtown Station, New York 18, N. Y.

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## AEC Approves TVA Nuclear Power Study

The Atomic Energy Commission (AEC) has approved an agreement with the Tennessee Valley Authority (TVA) whereby the TVA will make a study, similar to those under way by private industrial groups, of various economic and technical aspects of nuclear power production.

TVA, one of the nation's largest single power producers, will conduct a study aimed at reaching conclusions as to the immediate and long-range possibilities of commercial nuclear power.

TVA presently supplies a major portion of power for AEC facilities at Oak Ridge, Tenn., and Paducah, Ky.

All costs of the 1-year study will be borne by TVA. Reports and recommendations will be submitted to the AEC. Title to inventions and discoveries and disposition of reports made in the course of the study will be determined by the Commission.

A limited number of TVA personnel who will participate in the study have been or will be given security clearances after full investigation.

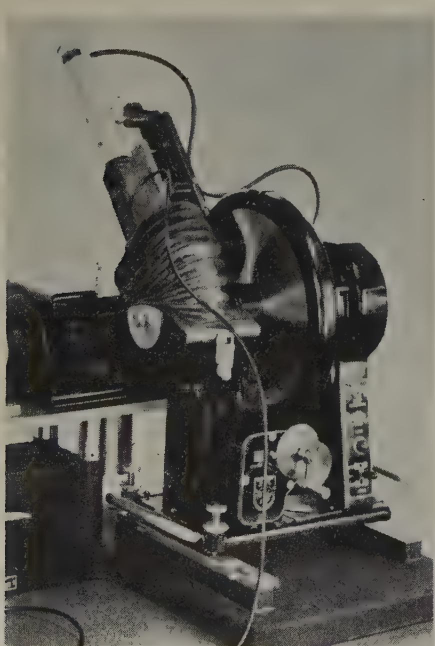
## Attachment for Spectrograph Permits Use of Helium for Air

A new attachment for Norelco X-ray spectrograph units which permits use of helium instead of air in the path of the X-ray beam, is available from the Research and Control Instruments Division, North American Philips Company Inc.

The helium atmosphere extends the useful spectrum range of the X-ray analysis equipment. With an air path and a rock-salt analyzing crystal, consistently good qualitative and quantitative results have been possible in the spectrum from calcium (atomic number 20) to uranium (atomic number 92).

With helium, present work now extends down to sulphur (atomic number 16). One recent fuel oil specimen containing 0.86-per-cent sulphur gave a net intensity of 16 counts per second above a background count of 0.8 count per second. Another specimen containing 0.56-per-cent sulphur gave a net intensity of 8 counts per second. Consideration of the results obtained indicates a probable sensitivity limit 0.02 per cent for sulphur, with comparable sensitivity limits for other elements in the same atomic range.

Accessory equipment includes a new housing that encloses the X-ray tube and provides a compartment for the specimen holder; a new plate-type collimator with mounting; and an accordion-shaped rubber jacket that encloses the analyzing crystal and connects the specimen compartment to the Geiger-tube-collimator assembly. The rubber jacket has a port for attachment of the helium supply tube.



**New helium attachment mounted on standard Norelco goniometer**

## Hand-Carried Electronic Device Inspects Rail Joints

A new hand-carried electronic device which inspects rail joints to the core of the steel by supersonic means, is now in use by the Pennsylvania Railroad.

In announcing the new "audigage flaw detector," as the device is known, the railroad reported it indicates imperfections that may develop in the rail at the ends, at switches and crossovers, and through paved highway crossings, long before flaws become visible to the eye. It augments other electronic devices employed to inspect the internal structure of rail generally.

The audigage is carried and operated by one man. It consists of a long-handled detector unit about the size of a paper weight, electronic equipment carried in a small pack on the operator's back, and a pair of earphones. As the operator slides the detector unit along the top of the rail at a joint, he hears in the earphones a steady, high pitched tone which descends to a growl whenever the detector passes over an imperfection. Should a flaw be discovered, the bolts and joint bars are removed to permit complete examination of the rail and its replacement.

With audigage detectors now in use in all areas of the system, the Pennsylvania is checking rail joints at a rate of 336,000 annually, representing more than 1,200 miles of track. In addition, rails in highway crossings are being examined, without disturbing the paving, at a rate of 14,500 crossings a year.

## General Electric to Equip Largest US Metal-Mine Hoists

More than a million dollars worth of General Electric equipment will power and control the two largest metal-mine hoists in the United States when they begin operation in 1955 at an Arizona copper mine.

The giant hoists will operate at a rope speed of more than half a mile a minute, and be capable of delivering 18 tons of copper ore to the surface every 72 seconds. The daily output of both hoists would fill a freight train $5^1/_4$ miles long, made up of 700 gondolas carrying 50 tons apiece.

Each of the two 6,000-horsepower double-cylindrical drum hoists, being built by the Nordberg Manufacturing Company, will be powered by two 3,000-horsepower 600-volt 500-rpm d-c mine-hoist motors.

A General Electric partial-equalizing flywheel motor-generator set—composed of two 2,500-kw mine-hoist generators, a 4,000-horsepower wound-rotor induction motor with liquid slip regulator, and a steel-plate flywheel—will furnish the 600-volt d-c power for each ore hoist.

The company also will supply complete amplistat-amplidyne control for automatic operation of the two skips in balance. The ore hoists are designed for 2-level operation and will be capable of lifting the 18-ton capacity bucket up the 2,425-foot shaft in $61^1/_2$ seconds.

A man-and-materials hoist with a maximum rope speed of 1,500 feet per minute also will be installed at the mine. Two 700-horsepower 400-rpm d-c motors will drive this service hoist which will transport workers and materials to the working levels.

The manually controlled service hoist will receive its power supply from a synchronous motor-generator set made up of two 600-kw generators and a 1,750-horsepower synchronous motor.

Also included in apparatus for the installation are lineups of 2,300-volt metal-clad switchgear for starting both the ore-hoist and the service-hoist motors.

## Water-Boiler-Type Reactor Designed for Nuclear Research

A powerful self-contained "percolating tea kettle" atomic energy reactor for special nuclear research has been designed and built by North American Aviation for the Atomic Energy Commission.

Developing 100 watts of power, the reactor is unique in that it is the largest unit of its type to operate with a closed cycle, or "self-contained" system. The "tea kettle" or water-boiler-type reactor, one in which the fissionable uranium compound is contained in a water solution, is designed so that all radioactive by-products of the fission process are retained in the unit instead of being exhausted and mixed with the open air, as in the case of other large reactors of this type. Radioactive by-products in the North American reactor are processed inside the unit and returned to the reactor core. It is possible for the reactor to run for as long as 10 years without refueling.

Nuclear research scheduled for the new reactor will include fundamental studies as well as test work with various materials and components being studied for possible application to atomic energy equipment and processes. At 100 watts of power the unit will produce a concentrated field of neutrons to bombard and irradiate test materials. If required, the reactor can be converted to operate at 2,000 watts of power to produce an even greater neutron "flux" or stream of neutrons sometimes required for more advanced or more critical experiments.

Power ratings for water boiler research reactors are much lower than those for other types under development by North American for the production of civilian and industrial

electric power. The company recently announced the design of an atomic pilot plant to produce 8,000,000 watts of electric power.

The reactor will be "fueled" with uranyl sulphate, enriched in fissionable Uranium 235, in a water solution. About 4 gallons of this material is housed in a steel sphere, 1 foot in diameter. A cylindrical stack of graphite bars, to reflect the neutrons produced by the fission process, surrounds the sphere. This entire assembly is housed by a steel tank 5 feet in diameter and 5 feet high. Two control and two safety rods, made of cadmium and boron, run through the tank to the sphere. Because these rods absorb neutrons, their presence near the sphere "shuts off" the fission process. When the rods are withdrawn the Uranium 235 solution begins the atomic fission process producing neutrons and other nuclear radiations. Access holes leading through the tank to the sphere permit the bombardment of test samples by neutrons and other radiations. During ordinary operation, only the two control rods are used to start, stop, and regulate the fission process. The two safety rods are designed to shut off the reaction automatically if required.

Inherent characteristics of the design of a water boiler reactor make it virtually impossible for the fission process to "run away." If an uncontrolled fission occurs, the heat of the reaction in the water solution will stop the process before damage can be done. The safety rods can be used with the same effect. In addition to the natural safety feature and the safety rods, the reactor is equipped with an auxiliary safety chamber system as a further safeguard. A completely new development, the safety chamber provides a method of reducing the amount of fissionable material in the sphere to less than a "critical mass," or to an extent that fission cannot occur. This is accomplished by a "percolating" process. If fission gets beyond a certain rate, gas bubbling through the uranyl sulphate solution carries the material into the auxiliary safety chamber and away from the fission sphere.

To obtain a stable power level for the reactor, North American's electromechanical engineering department has designed a special servo system to adjust the control rods automatically as required to maintain a given power setting, or rate of fission.

## Attention Called to Rules for Export of Technical Data

Persons sending technical data abroad are urged to co-operate with the United States Department of Commerce's rules for the export of technical information.

Under the rules of the department, a general license is required for the export of technical data. Such data are defined as any professional, scientific, or technical information, including any model, design, photograph, photographic negative, document, or other articles or material, containing a plan, specification, or descriptive or technical information of any kind which can be used or adapted for use in connection with any process, synthesis, or operation in the production, manufacture, or reconstruction of articles or materials.

Technical data in connection with advanced developments, technology, information, prototypes, special installations, and those items which do not have a security classification whenever they have significance to the common security and defense, are included in the scope of the security provisions.

Advertising catalogues or pamphlets, assembly and operating directions, or other technical information generally available to the trade, users of equipment, or to the public, are not included in the scope of the security provisions for technical data. Also excluded are technical data which are not classified by the U. S. Government and which will be used purely for educational or scientific research.

Before completing arrangements to export or release for foreign use any technical data included in the scope of the security provisions, exporters should request an official opinion from the U. S. Government through the Office of International Trade as to the desirability of exporting or releasing the technical data.

Complete information on these security provisions may be obtained from the Department of Commerce, Washington, D. C.

## Air Force Armament Center Seeks Engineers for Materials Tests

The U. S. Air Force Armament Center, Air Research and Development Command, is presently recruiting for engineers to accomplish tests of materials in the armament field and research and development of means to accomplish such tests; to provide support of the mission of the Air Research and Development Command; and to provide facilities for contractors and for governmental agencies. The salaries range from $3,410 to $10,800 per year.

Interested persons should submit a Standard Form *57*, Application for Federal Employment, to the Commander, Air Force Armament Center, Eglin Air Force Base, Fla. Standard Form *57*'s may be obtained at any U. S. Post Office.

## Electronic Computer Is Built of Unit-Packaged Circuits

A new and unique electronic computer was unveiled at Wayne University, Detroit, Mich., in December 1953 marking an important milestone in the progress of high-speed automatic computing techniques.

The "brain," known as UDEC—for Unitized Digital Electronic Computer—was designed and built by the Burroughs Corporation and installed in Wayne University's Computation Laboratory as part of a $500,000 community industrial education project instituted by Wayne and paid for by more than a score of Detroit's major industries.

UDEC is different from other electronic computers because of its "building-block" construction. "Because of this unitized construction," said Dr. Arvid Jacobson, director of the Wayne Computation Laboratory, "UDEC may never become obsolete."

The computer is built primarily of unit-packaged electronic circuits assembled one on top of the other in a steel framework. With flexible, removable components the computer

**Rear view of UDEC shows accessibility of tiered units for tube replacement, repair, and adjustment**

can be altered readily to incorporate advancements.

Primary purpose of UDEC in Wayne's educational program is to help train urgently needed personnel for the operation of the country's growing number of electronic computers and to seek new developments in the field of automatic data-processing equipment. In addition to this, the laboratory will be at the disposal of industry for the solving of practical problems in engineering, research, production, inventory control, and certain other business operations.

UDEC accomplishes the computation process by the generation of electric pulses and their manipulation through the pulse control units. Pulses, in terms of their application to the computer, are electric charges of extremely short duration (one ten-millionth of a second) which are grouped together in various combinations or codes to represent numbers and words. Morse code, with its combinations of dots and dashes, employs a similar principle. The groups of electric pulses comprising the answer to a problem are translated into arabic numerals by means of teletypewriter equipment.

As examples, UDEC might be called upon to solve problems involved in complicated mathematical tables derived from many diverse factors, like insurance tables, mortgage amortizations, artillery firing tables, and many other applications utilizing numerically graduating scales.

For engineers, it could determine stress and weight factors of a crankshaft or do a complete analysis of the entire engine. It is possible for the machine to compute the performance of mechanisms before they are built.

In design work the required dimensions and shapes of such things as cams, templates, or molds—many of which are directly based on algebraic and trigonometric formulas—can be worked out completely on the computer, thus eliminating drafting and blueprinting by providing a table of successive setup positions for milling machines and lathes.

## Radio-Supervised Master Clock Provides Accurate Time Control

A new radio-supervised master clock, designed to provide time control co-ordinated with the United States Bureau of Standards' broadcast time, is announced by International Business Machines Corporation (IBM). As a master control, it can keep all clocks, time equipment, and signaling devices in IBM electronic or electric self-regulating time systems at uniform and exceptionally accurate time.

The Bureau of Standards broadcasts time signals by short-wave radio from stations in Beltsville, Md., and Hawaii, on several different frequencies. The master clock contains a short-wave radio receiver which is tuned to these signals.

Once each hour, the master compares its accuracy with that of the time signal and, if it should be incorrect, resets itself automatically. A radio speaker mounted behind the dial can be switched on at any time to permit visual checking of the master's time to periodic voice announcements of time which are broadcast on the same frequencies as the signals.

If, because of poor reception, the master clock does not receive the broadcast time tone, it will attempt to pick up succeeding tones, which are broadcast every 10 minutes, until a check is made.

The clock mechanism consists of a precision spring-driven movement and a 60-beat invar pendulum to assure timekeeping accuracy and freedom from power frequency time variations.

## Polyethylene Developed for Ultrahigh-Frequency Insulation

A new cellular polyethylene with half the weight and a dielectric constant about one-half that of regular polyethylene has been developed by the Bakelite Company. The new material has been extruded at Bakelite Company laboratories on various sizes of wire and has been used successfully to insulate ultrahigh-frequency television lead-in wires.

"The new cellular polyethylene is expanded with the aid of a blowing agent which produces a material constructed essentially of unconnected cells," according to A. E. Maibauer, manager, Wire and Cable Materials Division. "With its lower specific gravity and reduced dielectric constant, the new cellular polyethylene is expected to prove especially useful in applications where weight savings in finished wire construction are necessary and where lower electrical attenuation and line losses are required, particularly at high frequencies."

"Besides an extremely low dielectric constant, excellent power factor, and good dielectric strength, the new cellular polyethylene has a high resistance to water penetration," Mr. Maibauer stated. "Due to these remarkable properties, the new cellular polyethylene has made commercially feasible the insulation of antenna lead-in wires for new ultrahigh-frequency and very-high-frequency television receivers.

"This new development opens up other commercial applications as yet unexplored, such as its use for flotation equipment. Cellular polyethylene floats in water much more readily due to its specific gravity of 0.47 as compared to 0.93 for standard polyethylene. The new Bakelite cellular polyethylene also retains to a large degree the exceptional chemical resistance of polyethylene which makes it impervious to corrosion by salt sea water, most acids, alkalies, and oxidizing agents."

## Wall-Mounted Fixtures Illuminate UN Roadways

Two different types of wall-mounted roadway lights have been installed at the main entrance of the United Nations in New York City. Type *VCD-12* roadway lighting fixtures illuminate the driveway in front of the General Assembly building; type *RL* ramp lights are in use along the ramp entrance and exit to the garage. Both types are manufactured by Crouse-Hinds Company.

The roadway lighting fixtures are of cast aluminum and contain an alzak, aluminum reflector, standard 200-watt incandescent lamp, inner lens of the asymmetric Fresnel type, and outer prismatic lens. It features a hinged door for easy relamping and an adjusting screw for beam control.

The ramp lighting fixtures—a new flush-mounted type made especially for installation at the United Nations—is an 11- by 13-inch rectangular aluminum housing containing a 200-watt standard incandescent lamp, alzak aluminum reflector cover, and prismatic lens.

The wall-mounted *RL* and *VCD* lighting fixtures concentrate a narrow beam of light on the road area. To prevent glare and to define the roadway sharply, they are mounted below the eye level of both pedestrians and motorists. There are no shadows cast by moving automobiles since the beams of each unit overlap—covering every spot on the roadway or ramp from several directions.

## Colorvision Slide Scanner Will Test Color TV Signals

A new Du Mont "Colorvision Slide Scanner," which will aid greatly in the development of color television by providing broadcasters and manufacturers with a video source for test purposes, has been developed by Allen B. Du Mont Laboratories, Inc.

Use of the new Du Mont "scanner" will provide manufacturers with exceptionally clear, reliable color signals with which to test television receivers now being designed in preparation for the advent of commercial color television.

The Du Mont Colorvision Slide Scanner is composed of two basic units; (1) the scanner, (2) the color optics and video amplifiers.

Heart of the Colorvision Slide Scanner is the new *TA-188-A* scanner unit. This contains the cathode-ray tube, scanning generator and high voltage supply, and an optically precise front-surface mirror for reflecting light from the cathode-ray tube to the slide unit.

The cathode-ray tube is a newly developed model which operates at 45 kv and produces an extremely bright light source. This increase in light output over previous designs retains high resolution and provides an output voltage which has high signal-to-noise characteristics. The tube has a high-quality neutral density faceplate having 66-per-cent transmission. The grey faceplate greatly improves small area contrast and increases "crispness" of the picture by reducing halation. The flying-spot scanning tube is positioned vertically. The mirror which directs the light is placed above the tube face.

The extremely small spot traces an unmodulated raster of high light intensity on the face of the cathode-ray tube. Light from this raster is directed to the front surface mirror and reflected to the slide changer section where it is focused through a lens system onto a 2- by 2-inch color transparency.

This light then is modulated by transmission through the transparency and is analyzed into its three component colors—red, green, and blue—by dichroic (color selective) mirrors. Additional filtering to insure good color purity is obtained by using photographic filters.

The light transmitted through this selective mirror system, after passing through the color filters, falls on three individual multiplier phototubes, one for each of the primary color channels. The signals generated by the multiplier phototubes then are passed through three phosphor persistence and gamma correction amplifiers, one for each color. The amplifiers also add blanking. Three simultaneous signals thus are obtained which then may be encoded according to National Television System Committee transmission specifications by the auxiliary equipment used by the manufacturer or broadcaster.

## New Type of Vacuum Pump Eliminates Organic Vapors

A new type of vacuum pump which eliminates the organic vapors that restrict the usefulness of conventional types of oil vacuum pumps for some purposes has been devised by University of Wisconsin physicists.

The new pump was described by Professor R. G. Herb, Ajay Divatia, and Robert Davis to physicists during the annual meeting of the American Physical Society.

The scientists said pumping speeds of greater than 6,000 liters a second for oxygen, nitrogen, and hydrogen were obtained with the new type of pump.

The pump uses wire made of titanium. The pump is so designed that titanium wire is continuously evaporated in a vacuum chamber by contact with a carbon rod heated electrically. The titanium condenses on the chamber walls and molecules of atmospheric gases either combine with the titanium molecules to form stable compounds or, in the case of inert helium, argon, and other noble gases, are ionized and driven to the wall of the vacuum chamber by electric fields where they are trapped and buried by the condensing titanium.

Continuous operation of the pump is achieved by automatic motion of the titanium wire into contact with the hot carbon rod as it progressively vaporizes.

The titanium pump is an improvement over the conventional oil pump because there is no possibility of oil or other organic compounds diffusing throughout the vacuum chamber. These compounds are particularly troublesome in research conducted in nuclear physics or with X rays because the

organic materials oxidize and form thin layers of carbon over the nuclear particle or X-ray targets, destroying their effectiveness.

The pump was developed to render more precise the experimentation which will be conducted when a new electrostatic generator being built at Wisconsin goes into operation.

"The pump shows considerable promise, but further development is needed before it will be dependable enough for long, trouble-free service," says Professor Herb.

## Oak Ridge Director to Speak on Progress in Use of Atomic Energy

Dr. Clarence B. Larson, director of the Oak Ridge National Laboratory, Oak Ridge, Tenn., will speak on "Progress in Atomic Energy Utilization," at a dinner meeting of the Massachusetts Institute of Technology Club of New York, Inc., on February 24, 1954. The public is invited to attend.

Dr. Larson has under his direction the administration of the largest of the Atomic Energy National Laboratories. In addition to basic scientific researches, the best-known achievements of the Laboratory are in the field of nuclear reactor development. It has had a part in the successful development of five reactors now in operation. Dr. Larson also has under his direction at Oak Ridge the production and distribution of radioactive and stable isotopes.

Reservations for the dinner must be made before February 20, 1954, through the Massachusetts Institute of Technology Club, 115 East 40th Street, New York 16, N. Y.

## Cadmium Storage Battery Has Long Life Expectancy

A new type of storage battery with a life expectancy of 10 to 20 years was demonstrated recently by Sonotone Corporation. The battery is half the size and will cost perhaps half as much as conventional batteries. It uses nickel cadmium cells of a special sintered plate type in place of lead.

While the initial cost of the battery is two to five times as much as the conventional type, it is expected that the actual cost will be considerably lower because of the long life expectancy.

One of the demonstrations of the battery showed its operation under circumstances that would cause other types to cease functioning. A nickel-cadmium unit was frozen in a cake of ice with cables through the ice connected to an automobile motor. The battery repeatedly started the motor without difficulty.

It also was shown to be unaffected by shock and vibration and to eliminate the worry of overcharging, reverse charging, or short-circuiting. It uses an alkaline solution instead of acid, requires only a few drops of water a year, and will operate at temperatures as low as 65 degrees below zero, Fahrenheit, and as high as 165 degrees above, although its life may be shortened under such conditions.

Tests have indicated that the cadmium battery has a minimum life expectancy of at least five times the ordinary lead plate battery, with a life in some cases of 20 years.

## Applications for AEC Fellowships Invited by Oak Ridge Institute

Applications for U. S. Atomic Energy Commission (AEC) Fellowships in Radiological Physics and Industrial Hygiene for the 1954–55 school year now are being received by the Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tenn.

The Industrial Hygiene fellowship program supports a limited number of individuals who are studying for the master's degree in this field at the Harvard University School of Public Health and the University of Pittsburgh Graduate School of Public Health.

Radiological Physics fellowships are carried out in three separate programs as follows: at Vanderbilt University and Oak Ridge National Laboratory, at the University of Rochester and Brookhaven National Laboratory, and at the University of Washington and Hanford Works. In each case, 9 months of course work at the university is followed by 3 months of additional study and field training at the co-operating AEC installation. Up to 25 fellows may be appointed in each of the three programs. Course work may be applied toward an advanced degree.

Basic stipend for both fellowships is $1,600, with an allowance of $350 for a spouse and $350 for each dependent child. In addition, tuition and laboratory fees are paid as a part of the fellowship. Industrial Hygiene fellows may receive an additional allowance of $200 if they have already completed a year of graduate study or appropriate work experience in this field.

The two fellowship programs are supported by the Atomic Energy Commission to supply the critical need for personnel trained in these fields. Radiological Physics deals with health problems associated with the handling of radioactive materials and with the release of nuclear energy. Industrial Hygiene encompasses the usual industrial hazards in addition to those peculiar to the atomic energy program, such as the handling of radioactive wastes and flue gases and the processing of unusual and often highly toxic material.

Application forms and additional information may be obtained from the Fellowship Office, University Relations Division, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tenn.

## Mechanical Arm Developed for Use in Radioactive Areas

What is believed to be the world's most powerful mechanical arm has been developed by the General Electric Company to substitute for human brawn in radioactive areas where men could not survive.

Named O-Man (for overhead manipulator), the 15-ton remote-controlled giant will make possible the assembly or disassembly of large machinery by the twist of a knob or the flick of a lever.

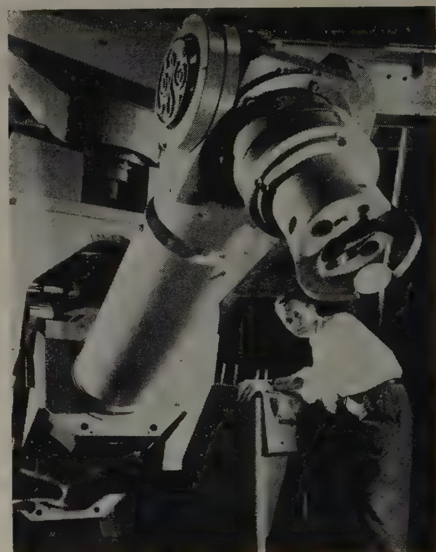
It has been developed for the company's aircraft nuclear propulsion department. The department is engaged in developing an atomic engine for aircraft under the sponsorship of the Atomic Energy Commission and the Air Force.

"Push-button" operations in buildings designed to prevent the escape of radiation are necessary in certain types of atomic energy work. O-Man's operator will work through special glass windows, with the aid of binoculars or a telescope.

The new mechanical arm has been built as the answer to the need for a device with several times the lifting power of existing mechanical arms, yet equal versatility.

By comparison, if a man were as strong as O-Man, he would be able to carry 5,000 pounds on his back, lift 3,000 pounds from the floor, hold 1,000 pounds with his arm extended horizontally, or lift and manipulate a piano with his forearm and wrist.

O-Man's chief job will be to pick up heavy parts, position them, and fasten them into place. It can drill and tap holes, use power wrenches, hammers, or riveters, and if need be, can handle a sheet metal saw.



**Steel "fingers" of the world's largest mechanical arm can manipulate weights up to 7,000 pounds, but their touch is also delicate enough to handle an egg**

In a strong man test, it twisted an iron bar into a corkscrew, then for good measure, tied it into a neat knot.

Although it will not be called upon for delicate tasks, O-Man has demonstrated that, with its twin steel fingers, it can whip up, slice, and serve a cake, or pick up and pour a glass of water.

Resembling a gun turret, the big device will operate from a crane bridge. Its vertical maneuverability will range from floor level to the height of the crane bridge.

While its grip lacks the flexibility of human fingers, it otherwise possesses the same degree of motion as the human hand and arm, plus the ability to telescope its "forearm" and revolve its "wrist."

Power control is brought to O-Man via 140 separate wires in multifestooned cable.

The heart of the control mechanism is a system of eight amplidynes, devices developed by General Electric that provide automatic control giving smooth operation and limiting all motions to prevent any damage to equipment.

## Submicrosecond Camera Is One of World's Fastest Cameras

Hycon Manufacturing Company has begun production of one of the world's fastest electronic cameras. The new camera can take a picture in only one-tenth of one-millionth of one second. Its speed is so great that it can chop a beam of light photographically into separate segments. Known as the Hycon Submicrosecond Camera, the first instrument was developed under contract with and has been put to work by the Ballistics Research Section of the Aberdeen (Md.) Proving Grounds.

The camera combines the sciences of physics and electronics. A Kerr cell of unique design acts as the shutter. The cell consists of two screens of polarized material separated by a solution of nitrobenzene. An electronic device applies a high electric potential across the cell. The shutter holds out light until the electric charge realigns the molecules of nitrobenzene, thus permitting light to pass through the cell and onto the film. There are no moving parts.

The new Hycon camera has been found to have a number of previously unanticipated uses in the study of industrial processes, such as the observation of jet engine combustion.

## Cal Tech Inaugurates 3–2 Plan for Admission of Some Students

The California Institute of Technology is inaugurating a "3–2 plan" for the admission of men from certain selected liberal arts colleges as juniors at the institute, President L. A. DuBridge has announced.

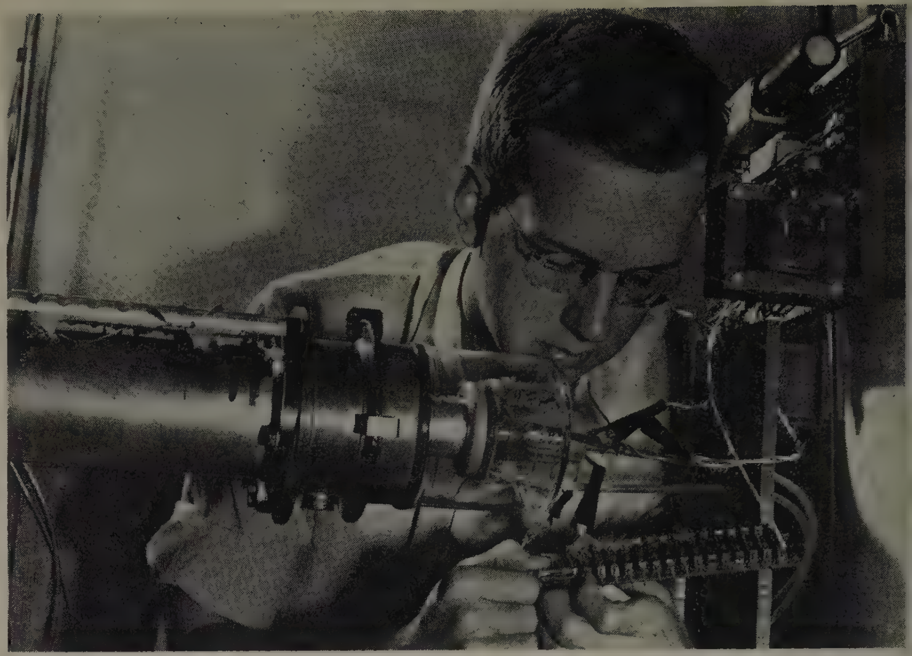
Colleges with which arrangements for participation in the plan have been completed include Occidental College, Los Angeles, Calif.; Pomona College, Claremont, Calif.; and Whitman College, Walla Walla, Wash.

Under the plan, a student may enroll in a co-operating college for an agreed-upon program for 3 years. On recommendation of the college he then will be admitted to the California Institute of Technology as a junior. When he satisfactorily completes 2 more years of work at the institute—for a total of 5 years of study—he will receive simultaneously the bachelor of arts degree from the college and the bachelor of science degree from California Institute of Technology.

"This program will appeal to certain types of students who will obtain in this way a most valuable college experience," Dr. DuBridge said. "In such a 5-year course the student will have more opportunity for work in nonscientific fields than in our 4-year course."

The institute faculty voted to initiate the plan, similar to 3–2 programs at other institutions, on a limited scale as an experiment. For the present, the plan will be limited to not more than five colleges, including Occidental, Pomona, and Whitman, and two others with which negotiations are now in progress, said Professor L. Winchester Jones, dean of admissions. If, as expected, the plan works out to the mutual benefit of the students and the colleges in the next few years, the number of participating institutions may be increased, he added.

## Small Linear Accelerator



**6,000,000-volt electron bullets will be fired at cancer from this glass-enclosed gun being tested at Stanford University. It is part of a small linear accelerator being built by microwave specialists. Radiologists will make tests of the junior-sized medical linear accelerator with the use of laboratory animals**

## Atomic Industrial Forum Issues Report on Congressional Hearings

In a report issued by the Atomic Industrial Forum, a group of seven leading experts from industry, labor, science, and the legal profession called for early relaxation of the government monopoly in atomic energy to stimulate competition and speed technological development for peaceful purposes.

Members of the group were Dr. Lloyd V. Berkner, president of Associated Universities, Inc., which operates the Brookhaven National Laboratory for the Atomic Energy Commission (AEC); James A. Brownlow, president of the American Federation of Labor's Metal Trades Department; Leonard W. Cronkhite, president of the Atomic Instrument Company of Cambridge, Mass; Gordon Dean, former AEC chairman now with Lehman Brothers in New York; Walter E. Kingston, general manager of the atomic energy division of Sylvania Electric Products, Inc., Bayside, N. Y.; Casper W. Ooms, Chicago attorney who is chairman of the AEC's Patent Compensation Board and a former U. S. Patent Commissioner; and Albert F. Tegen, president of General Public Utilities Corporation of New York.

The group concluded that the government's atomic monopoly should be relaxed through early revision of the Atomic Energy Act of 1946 to permit private ownership of atomic energy fuels and facilities paid for with private capital; more liberal patent rights than are presently available to industry, and a more effective sharing with industry of government-developed information useful in the peaceful development of atomic energy.

The group reached its conclusions during a conference sponsored by the Atomic Industrial Forum on November 19. The report is the first public release of the results of the conference, whose chairman was Dean E. Blythe Stason, chairman of the American Bar Association's special committee on atomic energy and dean of the law school of the University of Michigan.

In summing up the results of the conference in the report issued today, Dean Stason said the following points had been made:

1. There is a clear need for economically competitive atomic power.
2. It is virtually certain that nuclear reactor technology can be advanced to the point where atomic energy will be competitive generally with other sources of power.
3. The years immediately ahead should be devoted to intensive developmental activity.
4. In addition to government research and development, which should be continued within limits, free enterprise should be permitted, and encouraged, to participate as widely as possible to introduce the advantages of American competitive system into the atomic energy field.
5. To permit private participation, the present government monopoly in atomic energy should be relaxed as soon as possible with government control through regulation substituted for the present method of government control through direct ownership and management of all fuels and basic facilities.

The report is entitled "The Meaning of the Congressional Hearings on Atomic Energy." The conference it describes was the first activity of the Atomic Industrial Forum, which was established last April to further the development of atomic energy for peaceful purposes. Copies of the report can be ordered at $1.00 each from the Atomic Industrial Forum, Inc., 260 Madison Avenue, New York 16, N. Y.

# LETTERS TO THE EDITOR

**INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.**

## American Register of Engineers

A copy of the following letter was received by the editor and is reprinted here as a matter of general interest.

• • •

W. C. Ogle, President
Empire Publishing Company
Corona Del Mar, Calif.

Dear Mr. Ogle:

As chairman of the Engineers Joint Council Advisory Committee on "Who's Who in Engineering," my attention has been directed to the circularization of engineers by your organization. The "American Register of Engineers" duplicates the biographical service of "Who's Who in Engineering," which has been published since 1922 and is now in the seventh edition, to appear early in 1954.

It is the opinion of the committee that no good purpose can be served by this duplication and that the new solicitation is unwarranted. "Who's Who in Engineering" has collaborated effectively with the engineering profession and supplies a valuable biographical service that should not be handicapped by confusion with another publication.

Very sincerely yours,

A. A. POTTER

(Dean Emeritus of Engineering, Purdue University. Lafayette, Ind.)

### Library Services

ENGINEERING Societies Library books may be borrowed by mail by AIEE members for a small handling charge. The library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

# NEW BOOKS • • • • •

**The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.**

ALTERNATING CURRENT MEASUREMENTS. By David Owen. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., third edition, 1953. 120 pages, $6^3/_4$ by $4^1/_4$ inches, bound. $2. A brief account of the measurement of resistance, inductance, and capacitance by the use of alternating current, mainly at low frequencies but including a chapter on radio frequencies. Special attention is paid to the a-c potentiometer and its applications. Minor revisions and corrections have been made in this edition.

CAMBRIDGE ELEMENTARY STATISTICAL TABLES. By D. V. Lindley and J. C. P. Miller. Cambridge University Press, 32 East 57th Street, New York 22, N. Y., 1953. 35 pages, 11 by $8^1/_2$ inches, paper. $1. A set of ten tables of the commoner statistical functions and tests of significance for users of statistical methods in scientific research, technology, and industry. Tables included are for the normal distribution and frequency functions, percentage points of various derivations of the normal distribution, the correlation coefficient and other common transformations, and random sampling numbers.

COMPLEX VARIABLE THEORY AND TRANSFORM CALCULUS. By N. W. McLachlan. Cambridge University Press, 32 East 57th Street, New York 22, N. Y., second edition, 1953. 388 pages, $8^3/_4$ by $5^3/_4$ inches, bound. $10. Parts I and II dealing with the theoretical aspects have been rewritten to provide increased mathematical rigor. Part III on applications has been revised to conform with current practice. The wide range of examples includes electric circuits, vibrational systems, airplane dynamics, radio and television receivers, transmission lines, electric wave filters, heat diffusion, submarine cables, etc.

DAVISON'S TEXTILE BLUE BOOK. 88th year, July 1953 edition. Davison Publishing Company, Ridgewood, N. J., 1953. 1,549 pages, $8^1/_8$ by 5 inches, bound. $6.50. A complete and comprehensive annual directory of the textile industry in the United States and Canada. New mills and firms, testing laboratories, textile schools, associations, manufacturers, and dealers have been added since last edition. Thumb-indexed in addition to complete alphabetical and geographical indexes to mills, dyers, and raw cotton firms. The book is available either with or without the "buyers guide" for machinery and equipment.

MICROWAVE LENSES. By J. Brown. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1953. 125 pages, $6^3/_4$ by $4^1/_4$ inches, bound. $2. Both theory and practice are covered in dealing with the design of dielectric lens aerials on the basis of geometrical optics. The properties of suitable dielectrics are discussed, and various types of lenses for the centimeter wavelength field are described.

MODERN ELECTROPLATING. Edited by Allen G. Gray. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1953. 503 pages, $9^1/_4$ by $6^1/_4$ inches, bound. $8.50. A complete revision of the Electrochemical Society's publication issued with the same title in 1942. Almost all important plating processes are discussed from both the practical and theoretical points of view with information given on principles, constituents of baths, operating conditions maintenance and control, preparation of basis metals, and finishing of deposits. A chapter is included on the plating of uncommon metals.

NUCLEAR PHYSICS. By W. Heisenberg. Philosophical Library, 15 East 40th Street, New York 16, N. Y., 1953. 224 pages, $7^1/_2$ by 5 inches, bound. $4.75. This is a book for those who have no training in theoretical physics but who are acquainted with physical ideas. An historical introduction is followed by chapters on the structures of molecules and atoms, radioactivity, atomic nuclei, nuclear forces and reactions, and instruments and procedures of the nuclear physicist. There is a final chapter on applications.

PAST EXAMINATIONS FOR PROFESSIONAL ENGINEER—New York State. Compiled by John D. Constance, 625 Hudson Terrace, Cliffside Park, N. J., 1953 edition. 11 by $8^1/_2$ inches, paper. $1.50. This compilation of problems from past Professional Engineers License Examinations in New York State now covers the period from January 1943 through June 1953. It includes the complete set of Parts I, II, and III in all cases.

RADIOACTIVITY AND RADIOACTIVE SUBSTANCES. By Sir James Chadwick. Revised and supplemented by J. Rotblat. Pitman Publishing Corporation, 2 West 45th Street, New York, fourth edition, 1953. 120 pages, $7^1/_2$ by 5 inches, bound. $3. A book on classical radioactivity which serves as a primer in this special field or as a general introduction to nuclear physics. Basic phenomena of natural radio activity, and how these have led to present concepts of the structure of matter, are discussed simply and concisely. A chapter on nuclear structure has been added in this edition.

SIMULTANEOUS LINEAR EQUATIONS AND THE DETERMINATION OF EIGENVALUES. (Applied Mathematics Series, no. 29.) National Bureau of Standards. Available from Superintendent of Documents, Government Printing Office, Washington 25, D. C., 1953. 126 pages, $10^1/_2$ by 8 inches, bound. $1.50. Detailed explanations of various mathematical procedures for the solution of systems of linear equations and the determination of eigenvalues, together with a tentative classification of methods and an extensive general bibliography. A brief specialized list of references accompanies each particular procedure.

SPACE TRAVEL. By Kenneth W. Gatland and Anthony M. Kunesch. Philosophical Library, 15 East 40th Street, New York 16, 1953. 205 pages, $8^3/_4$ by $5^3/_4$ inches, bound. $4.75. Beginning with a brief historical summary, the authors continue with a technical exposition of the rapid developments in rocket research from World War II on, including many aspects pertinent to human travel by this means. The artificial satellite is considered from a practical point of view, operations in space are dealt with, and the problems and rewards of flight beyond the solar system are discussed briefly.

SPENDING FOR INDUSTRIAL RESEARCH, 1951–1952. By De Witt C. Dearborn, Rose W. Kneznek, and Robert N. Anthony. Harvard University, Graduate School of Business Administration, Boston 63, Mass., 1953. 103 pages, 11 by $8^1/_2$ inches, paper. $2.50. Summarized quantitative information is given including scale of expenditures for research and development by industrial firms and variations of such expenditures among firms by industry and size. There are many tables analyzing total cost of research, broken down into cost per research worker, cost of research, classification by types and size of industry, and research financed by Federal Government.

TECHNICAL ASPECTS OF SOUND. Volume I: Sonic Range and Airborne Sound. Edited by E. G. Richardson. Elsevier Publishing Company, 402 Lovett Boulevard, Houston, Tex., 1953. 544 pages, $9^1/_4$ by $6^1/_4$ inches, bound. $11. This is the first of two volumes intended to provide a handbook covering the technical aspects of sound at a fairly advanced level. Following an introduction on basic theory and symbols, various specialists have contributed chapters on subjects within the following broad divisions: acoustic measurements and materials; acoustics of buildings; noise; speech and hearing; sound reproduction; analysis and synthesis of sound. The second volume will deal with the ultrasonic range.

THE VAN NOSTRAND CHEMIST'S DICTIONARY. Edited by Jurgen M. Honig and others. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York 3, N. Y., 1953. 761 pages, $9^1/_4$ by $6^1/_4$ inches, bound. $10. Although of primary interest to chemists, engineers may find need of definitions of some of the 11,000 terms in this semi-encyclopedic work. The definitions vary from a few words to several paragraphs, and effective cross-indexing is provided by printing all listed words and topics in bold-face wherever they appear.

DESIGN AND CONSTRUCTION OF GENERAL HOSPITALS. By U.S. Public Health Service. F. W. Dodge Corporation, 119 West 40th Street, New York 18, N. Y., 1953. 214 pages, $11^3/_4$ by 9 inches, bound. $12. Summarized results of research by various associations and other authorities in the public health field. Its importance to engineers and architects lies in the detailed treatment of structure and layout planning, mechanical and electric equipment, site problems, costs, and specialized construction requirements. Master plans are provided for various sizes of hospitals.

DISCONTINUOUS AUTOMATIC CONTROL. By Irmgard Flügge-Lotz. Princeton University Press, Princeton, N. J., 1953. 168 pages, $9^1/_2$ by $6^1/_2$ inches, bound. $5. Mechanical systems which have restoring forces, other than that of the control device, form the subject of this monograph. Their motions under the influence of discontinuous controls are studied in detail. The methods and results are not restricted to mechanical systems but apply also to thermodynamic and electric systems whenever the differential equations are of the same form.

ENGINEERING LAW. By R. E. Laidlaw and C. R. Young. University of Toronto Press, Toronto, Ont., Canada, fourth edition, 1951. 394 pages, $9^1/_4$ by $6^1/_4$ inches, bound. $5.25. A simple presentation of those phases of Canadian law that relate to engineering, using a minimum of technical legal terms and avoiding subtle legal distinctions and conflicts. It covers contracts and specifications, arbitration, expert evidence, compensation, patents and inventions, and a wide range of engineering activities. Extracts from reports of typical cases have been added for illustration in the new edition.

HIGHER TRANSCENDAL FUNCTIONS, Volume II. Compiled by the Bateman Manuscript Project at the California Institute of Technology. McGraw-Hill Book Company, Inc., 330 West 42d Street, New York 36, N. Y., 1953. 396 pages, $9^1/_4$ by $6^1/_4$ inches, bound. $7.50. This second volume of a comprehensive 3-volume reference work for engineers, physicists, and mathematicians covers the following: Bessel and related functions; error functions; exponential, sine, and cosine integrals and related functions; parabolic cylinder functions; orthogonal polynomials; elliptic functions and integrals. These extensive and detailed treatments have been developed by four outstanding mathematical analysts.

HYDROCARBONS FROM PETROLEUM. (American Chemical Society, Monograph no. 121.) By Frederick D. Rossini, Beveridge J. Mair, and Anton J. Streiff. Reinhold Publishing Corporation, 330 West 42d Street, New York 36, N. Y., 1953. 556 pages, $9^1/_4$ by $6^1/_4$ inches, bound. $18.50. This book summarizes in convenient form the results of over 25 years of research on hydrocarbons by the American Petroleum Institute. Among the many aspects of the subject covered are principles of fractionating processes; apparatus for various methods of fractionating; procedures and apparatus for measuring physical properties; a summary of present knowledge of the composition of petroleum; and the analysis of certain refined petroleum products. Frequent reference is made throughout the study to the basic work of others.

INFORMATION THEORY. By Stanford Goldman. Prentice-Hall, Inc., 70 Fifth Avenue, New York, N. Y., 1953. 385 pages, $8^3/_4$ by $5^3/_4$ inches, bound. $9. A comprehensive treatment for the first-year graduate student in electrical engineering, based on the pioneering and classical work of Shannon and Wiener with modifications so that the information aspects of individual messages can be treated more readily. Major topics are the transformation of both information and constraints from the time to the frequency domain, sampling theorems, and the information theory aspects of random noise.

MANUAL OF TRAFFIC ENGINEERING STUDIES. Accident Prevention Department of the Association of Casualty and Surety Companies, 60 John Street, New York, N. Y., second edition, 1953. 278 pages, 11 by $8^1/_4$ inches, bound. $3.75. A comprehensive reference work on the methods, forms, and analysis of traffic studies, designed to be of use to city planners, transportation officials, police, and students, as well as to traffic engineers. In addition to the 28 case studies there is also information on the origin, financing, and planning of surveys, on statistical treatment of data, report preparation, and other aspects. Revised to incorporate recent significant developments.

ASME HANDBOOK. Metals Engineering-Design. Edited by Oscar J. Horger. Sponsored by Metals Engineering Handbook Board, The American Society of Mechanical Engineers. McGraw-Hill Book Company, Inc., 330 West 42d Street, New York 36, N. Y., first edition, 1953. 405 pages, $10^1/_4$ by $7^1/_2$ inches, bound. $10. Some 40 authorities summarize the important reference data and discuss the essential properties which need to be evaluated by the design engineer in his selection of materials, beginning with an over-all discussion of the problem. Section II on mechanical properties covers high-temperature considerations, plasticity, stresses, vibration, fatigue, cold-working, impact, and other considerations. Part III deals with corrosion and mechanical factors which influence corrosion. Part IV presents metallurgical factors, mainly dealing with nondestructive methods of testing. Part V considers the requirements for mass production and surface finish. Part VI treats design theory and practice, and miscellaneous topics such as elasticity, strain gauges, photoelasticity, plates and shells, and the special requirements of aluminum and magnesium.

AUTOMATIC DIGITAL CALCULATORS. By Andrew D. Booth and Kathleen H. V. Booth. Academic Press, Inc., 125 East 23d Street, New York 10, N. Y., 1953. 231 pages, $8^3/_4$ by $5^3/_4$ inches, bound. $6. A guide to the theory, design, construction, and use of digital calculators, written for new workers in the field. Following introductory chapters on the nature, function, and history of calculators, the book deals with design, controls, storage, coding, and programming. Brief treatment of applications in crystallography, translation, and games is given in the last chapter. A bibliography is included.

COST REDUCTIONS IN WIRE COMMUNICATIONS. By Roy Stone. Christopher Publishing House, 1140 Columbus Avenue, Boston 20, Mass., 1953. 342 pages, $9^1/_2$ by $6^1/_2$ inches, bound. $10. Written in nontechnical language for the engineer, service superintendent, or office manager normally in charge of company telecommunications, this book presents basic facts about telephone and telegraph apparatus and service arrangements, and shows how economies can be made readily and service improved. It deals with problems of telephone service for small-, medium-, and large-scale businesses, privately owned systems, teletypewriter service, and commercial telegraph services, and includes a separate chapter on the management of communications.

ENGINEERING ELECTRONICS. By George E. Happell and Wilfred M. Hesselberth. McGraw-Hill Book Company, Inc., 330 West 42d Street, New York 36, N. Y., 1953. 508 pages, $9^1/_4$ by $6^1/_4$ inches, bound. $7.50. Elementary in nature, theoretical with practical application, this textbook is designed for use in a beginning course for electrical engineering students. Major coverage is as follows: physics of vacuum tubes; characteristics of common tube types; vacuum-tube circuit analysis; detailed studies in amplifiers, oscillators, and modulating devices; conduction through gases; high-vacuum and gaseous rectifiers; photoelectric cells; and solid-state electronics.

JAPAN'S NATURAL RESOURCES AND THEIR RELATION TO JAPAN'S ECONOMIC FUTURE. By Edward A. Ackerman. University of Chicago Press, Chicago, Ill., 1953. 655 pages, $10^1/_4$ by $7^1/_2$ inches, bound. $25. A study of the country's physical endowments, including mineral industries, energy sources, and water supply, in relation to the basic human needs of the population, and of the possibilities of integrated resource management. An analysis of the character of resources and requirements is followed by suggestions as to advances in the efficiency of resource use and associated problems and by a discussion of Japan's position in relation to the western world. Excellent photographs, maps, charts, and tables make this valuable for reference.

MICROWAVE THEORY AND TECHNIQUES By Herbert J. Reich and others. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York 3, N. Y., 1953. 901 pages, $9^1/_4$ by $6^1/_4$ inches, bound. $12.50. Intended primarily as a text for a senior or first-year graduate course, this book is also useful as a reference work for research workers or engineers. Following an introduction on vector mathematics and chapters on the theory of static and dynamic electromagnetic fields, the book deals extensively and in detail with the physical analysis and characteristics of such microwave devices as amplifiers, oscillators, resonators, klystrons, and magnetrons. Problems and laboratory experiments are included, and a bibliography follows each chapter.

PRINCIPLES OF TRANSISTOR CIRCUITS. Edited by Richard F. Shea. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1953. 535 pages, $9^1/_4$ by 6 inches, bound. $11. This first comprehensive treatment of the subject divides roughly into three main parts covering essentially low-frequency, high-frequency, and large-signal nonlinear applications. Each part includes the presentation and analysis of equivalent circuits, analysis of the mathematical relationship, and development of the applicable circuits. Basic semiconductor principles are discussed, and the treatment throughout enables the engineer with vacuum-tube experience to utilize the material effectively.

TECHNISCHE DYNAMIK. Volume I: Grundlagen und Einzelne Maschinenteile. Volume II: Dampfturbinen und Brennkraftmaschinen. By C. B. Biezenö and R. Grammel. Springer-Verlag, Berlin, Germany, second edition, 1953. 699 pages, 452 pages, 10 by 7 inches, bound. DM 66.00, DM 44.00. The two volumes of this comprehensive text on engineering dynamics cover respectively: basic principles and individual machine elements; steam turbines and internal-combustion engines. A subject index covering both volumes is included in each. The new edition has been revised, with numerous additions.

TEMPERATURE MEASUREMENT IN ENGINEERING, VOLUME I. By H. Dean Baker, E. A. Ryder, and N. H. Baker. John Wiley and Sons, Inc., 440 Fourth Avenue, New York, N. Y., 1953. 179 pages, $9^1/_4$ by $6^1/_4$ inches, bound. $3.75. This first volume of a 2-volume work is primarily concerned with thermocouple techniques and includes introductory chapters on fundamentals, basic information necessary for the design of temperature measuring apparatus, and specific designs for measuring internal temperatures and temperature gradients in solid bodies. The emphasis is on specific procedures and techniques for various circumstances, classified on a physical basis rather than by industry or type of instrumentation.

## PAMPHLETS • • • • •

**The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers.**

**Productivity Report.** Report of a British team of machine tool builders visiting the United States describes the present status of American inspection for quality and accuracy, and the major role inspection plays in trouble-shooting. The report also outlines the kind of organization prevalent for achieving the desired accuracy. Stress is laid on the important functions performed by inspectors and on the instruments and gauging standards they use to maintain the high quality found in most machine tool shops. 84 pages, illustrated with charts and graphs. 75¢. Available from the Office of Technical Services, United States Department of Commerce, Washington 25, D. C.

**Water Systems Manual.** A new edition of the Manual of Water Supply Equipment has been published by the National Association of Domestic and Farm Pump Manufacturers. Covering every phase of the subject of water supply beyond the reach of municipal water mains, the manual takes account of the changes in minimum water requirements occasioned by the use of new appliances. It contains complete engineering data. $1.50. Copies can be obtained from the National Association of Domestic and Farm Pump Manufacturers, 39 South La Salle Street, Chicago 3, Ill.

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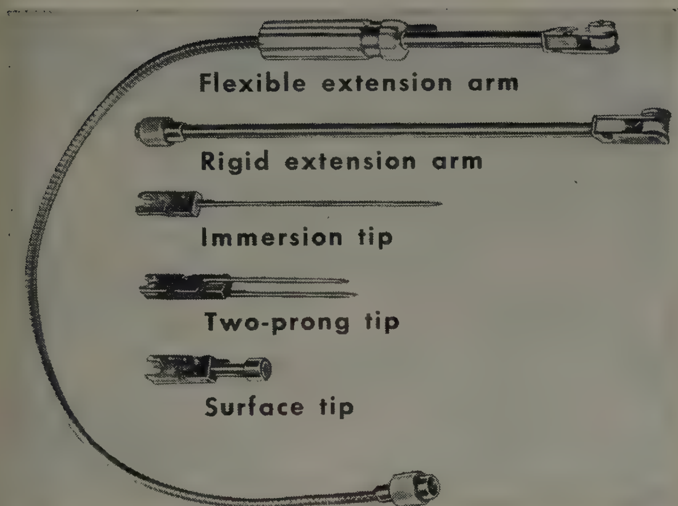



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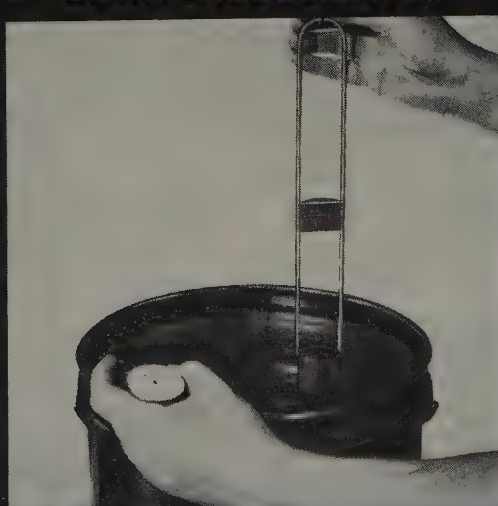

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**GENERAL ELECTRIC**

# INDUSTRIAL NOTES ....

**General Electric News.** An announcement that the General Electric Company plans to build a multimillion dollar plant and headquarters at Holland, Mich., for its hermetic motor department was made recently. The new installation will be a single-story structure, using the latest fabricating equipment and methods. Present plans call for breaking ground next spring, and manufacturing will start early in 1955.

Three men have been named to key managerial posts in the company's public relations and advertising operations. Kenneth G. Patrick, New York, N. Y., has been appointed manager of educational relations services in the company's Public Relations Service Division. He will be succeeded in his former position as manager of general public relations services by J. Stanford Smith of Schenectady, N. Y. Concurrently, Ralston B. Reid has been named to replace Mr. Smith as manager of advertising and sales promotion for the Apparatus Sales Division at Schenectady.

Appointments of three new regional managers for communication equipment in the commercial equipment department were announced. The new regional managers will have responsibility for mobile 2-way radio and microwave communication equipment. I. M. Ellis was appointed regional manager for the West Coast, with headquarters at San Francisco, Calif. He succeeds Mr. Sheeley who was transferred recently to Syracuse, N. Y., as manager of sales. G. F. Reed was appointed regional manager with headquarters at Detroit, Mich., succeeding R. L. Casselberry, recently transferred to Syracuse as manager of product planning and marketing research. G. P. Foster was named regional manager for the Midwest, with headquarters at Chicago, Ill. He succeeds H. N. McNeill, who recently was transferred to Syracuse as manager of product service.

The appointment of Clayton Ryder, formerly of Schenectady, as district sales manager for the tube department replacement sales was announced. Mr. Ryder will make his headquarters at 963 Commonwealth Avenue, Boston, Mass. His territory will include the Boston, Bangor, Manchester, and Portland trading areas. He succeeds Paul P. Wickman, who has been transferred to replacement sales staff duties at the tube department headquarters in Schenectady.

**Henderson to Represent Burndy.** Burndy Engineering Company, Inc., Norwalk, Conn., manufacturers of electrical connectors, announced the appointment of the Henderson Sales Company as sales representatives for the St. Louis, Mo., area, replacing W. L. Rose, who is retiring as sales representative after 45 years in the electrical field. The Henderson Sales Company, presently located in offices at 8131 Manchester, Brentwood, St. Louis 17, consists of Erwin E. Henderson and Harlan J. Weisler.

**Philco Changes.** Philco Corporation has signed an agreement to acquire the net assets of the Dexter Company of Fairfield, Iowa, manufacturers of washing machines and dryers, subject to approval of the Dexter stockholders. Philco plans to continue operation of the Dexter Company under its present management as a separate unit. Its output of washers and dryers will be marketed under the Dexter name. Entry into the home laundry field will round out the Philco program of major appliances, which already includes television, radio, refrigerators, freezers, air conditioners, and electric ranges.

**Johns Hopkins University Promotion.** Henry H. Porter, supervisor of the Johns Hopkins University, Applied Physics Laboratory's Bumblebee Guided Missile Program since 1948, recently was named as an assistant director of the Laboratory for Planning. Dr. R. E. Gibson, director of the Laboratory, who made the announcement, explained that Mr. Porter chiefly will be concerned with laboratory planning, policy, and objectives.

**IBM Appointments.** International Business Machines Corporation has announced the appointment of Edwin S. McCollister and R. B. Smith as special representatives in its electronic data processing department. Mr. McCollister previously was an administrative assistant in the market analysis and field testing department, and Mr. Smith was a sales representative in the company's Santa Monica, Calif., office. In this new assignment they will coordinate IBM field sales activities in connection with electronic data-processing equipment designed for commercial use.

**I-T-E Acquires Victor Insulators.** I-T-E Circuit Breaker Company of Philadelphia, Pa., has acquired Victor Insulators, Inc., Victor, N. Y., manufacturers of high-voltage electric porcelain insulators used in the transmission and distribution of electric power. Victor Insulators will continue to operate under its own corporate name in Victor, as a subsidiary of I-T-E. W. M. Scott, Jr., president of I-T-E, will become president of Victor, and Edward A. Halbleib, now its president, will become chairman of Victor's board of directors and will join the board of I-T-E. No other changes in the personnel or policies of Victor are presently contemplated.

**U. S. Rubber Plans Research Center.** The United States Rubber Company has announced that it has acquired options to purchase a 90-acre tract of land in Preakness, Wayne Township, N. J., on which it plans to construct a new research center devoted to scientific research and develop-

(*Continued on page 22A*)


OLD DESIGN
NEW DESIGN
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D C AMPERES

*(Continued from page 18A)*

ment in the fields of rubber, chemicals, textiles, and plastics. The research center calls for the construction of three new, modern laboratory buildings and service buildings at an approximate cost of $4,000,000. The company's present research and development activities, now conducted in its general laboratories in Passaic, N. J., will be transferred to the new location.

**Du Mont Appointments.** The board of directors of Allen B. Du Mont Laboratories, Inc., has approved the appointment of three new vice-presidents. They are Thomas T. Goldsmith, Jr., vice-president, research; Irving G. Rosenberg, vice-president, tubes and government; and C. Edwin Williams, vice-president, instruments and transmitters.

**Canadian Subsidiary.** Servomechanisms, Inc., designers and producers of electronic and electromechanical control systems and computers, with three divisions in the United States, recently acquired a wholly owned subsidiary, Industrial Electronics of Canada, Ltd. The new subsidiary is a well-established manufacturer of industrial electronic and electric equipment located in Toronto, Ontario, Canada. The new subsidiary company, which will continue to operate under its own name, has become widely known in Canadian industrial circles. Alexander S. Mackie will continue as president of this company as will Donald L. Stewart as treasurer with the added duties of secretary. Croydon H. Hartley, sales director of Servomechanisms, Inc., has been appointed vice-president.

**New Bakelite Plant.** Production of polyethylene, one of the three critical industrial materials still in short supply, has increased 45 per cent with the achievement of full-scale operation at the new plant in Texas City, Tex., according to a recent announcement of the Bakelite Company, a Division of Union Carbide and Carbon Corporation. With its production capacity rated at more than 60,000,000 pounds per year, this new plant is the first to come into production of the three new polyethylene plants announced by the Bakelite Company.

**RCA News.** The RCA Victor Division, Radio Corporation of America, has started construction on a group of ultramodern buildings to serve as administration and laboratory headquarters for the Home Instrument and Service Company activities. The project, which was almost a year in planning, will contain five interconnected buildings and will be located on a 58-acre tract in the suburban Cherry Hill section of Camden, N. J. It is scheduled for completion in the fall of 1954.

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*(Continued on page 28A)*

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(*Continued from page 22A*)

tronic plants for engineering and development of radar techniques for national defense was dedicated on December 5, 1953, by the RCA Victor Division. Established to handle expanded government study and production projects in the vital field of radar engineering, the streamlined 1-story plant is located in Moorestown, N. J.

**New Steel Container Plant.** United States Steel Products Division soon will start construction of a steel container plant on a 26.7-acre plot in Pennsauken Township, Camden County, N. J., it was announced. The new plant, designed for the production of steel drums and pails for the petroleum, chemical, paint, food, and other industries, will have 168,000 square feet of floor space. Construction is expected to be completed early in 1955.

**Square D Gives New Assignments.** Lawrence G. Maechtlen, vice-president of the Square D Company, has been named manager of its western division, and J. H. Pengilly, also a vice-president, has been named chairman of the western division's executive committee. Both appointments, made by the board of directors at its recent meeting, became effective January 1.

**New Westinghouse Atomic Plant.** Engineering and other office personnel are moving into the new plant of the Westinghouse atomic equipment department. Located in Harmar Township approximately 1 mile northeast of the Allegheny Valley Interchange of the Pennsylvania Turnpike, the plant is part of the Westinghouse Atomic Power Division which is building the atomic submarine engine for the *U.S.S. Nautilus* and developing the first civilian atomic power plant. The new plant will produce component parts and represents initially a $2,000,000 investment by Westinghouse Electric Corporation.

## NEW PRODUCTS • •

**New Polyethylene.** A new cellular polyethylene with half the weight and a dielectric constant about one-half that of regular polyethylene, has been developed by the Bakelite Company, a Division of Union Carbide and Carbon Corporation. The new material has been extruded at Bakelite Company laboratories on various sizes of wire and has been used successfully to insulate ultrahigh-frequency television lead-in wires.

**New Substation.** A new mechanical rectifier unit substation for providing d-c

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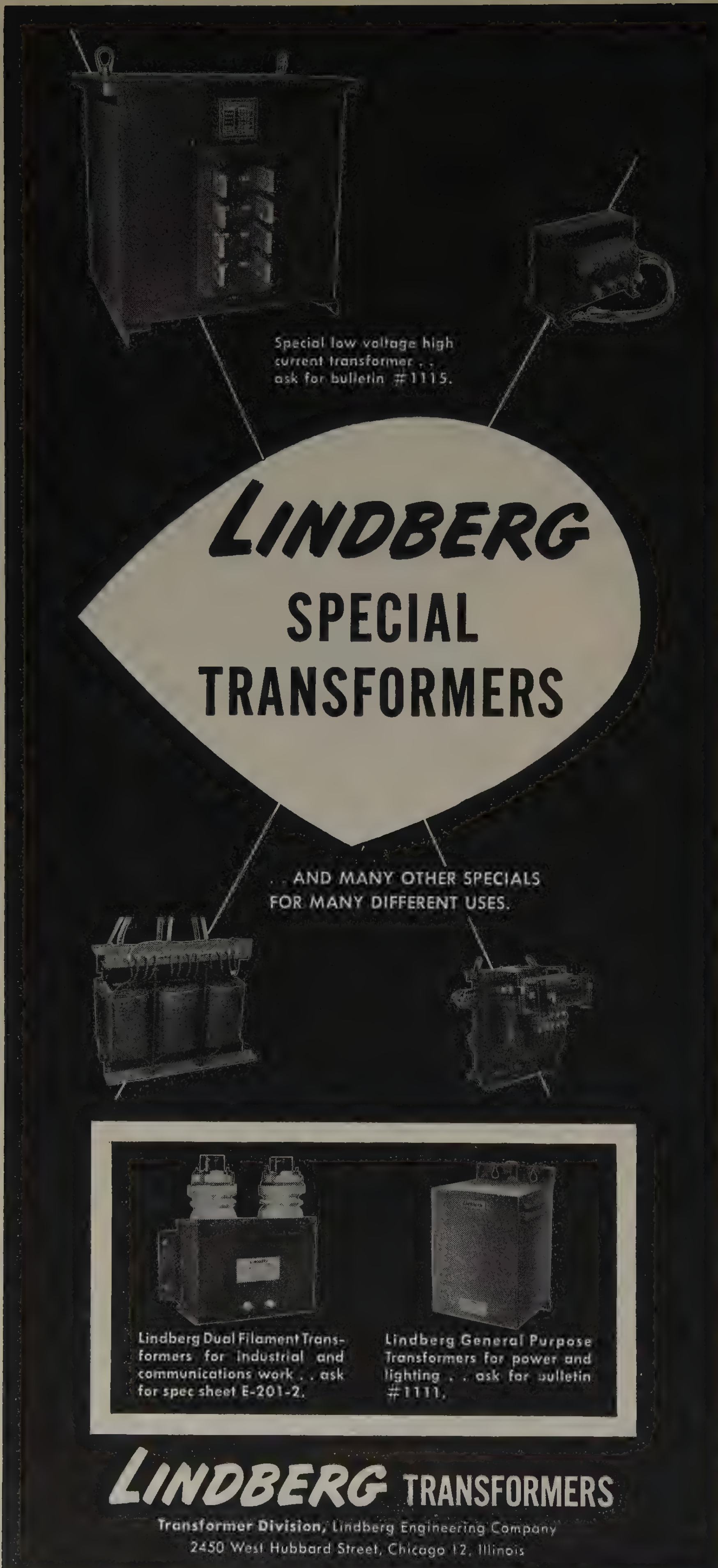


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power has been announced by the General Electric Company's low voltage switchgear department at Philadelphia, Pa. The substation has an efficiency of more than 96 per cent including losses in the transformers, switchgear, and other associated equipment. Mechanical rectifier units are available for providing up to 12,000 amperes at voltages up to about 250 volts direct current. Above this voltage the units are usually rated 6,000 amperes up to approximately 500 volts direct current. Several rectifier units may be operated in parallel to provide larger amounts of current if required. The unit is designed to be an integral part of a substation equipment line-up for transformation of alternating current to direct current.

**Low-Noise Junction Transistor.** The Raytheon Manufacturing Company, Receiving Tube Division, has announced the addition of a low-noise junction transistor to its line of *PNP* junction transistors. This new type, *GK727*, has an average noise factor of 13 decibels, an average alpha of 0.97, and an average power amplification of 37 decibels. Full details are given in a data sheet available from Technical Information Service, at the Raytheon plant, 55 Chapel Street, Newton, Mass., or from any Raytheon sales office.

**Ford Size 15 Telesyn Resolver.** An extremely accurate computing unit of miniature size and light weight, the Ford Instrument Company Size *15* Telesyn Resolver, continuously performs trigonometric operations involving resolution of input voltages into sine and cosine components. It is available in three models with transformation ratios of 1:1, 4:1, and 8:1, making it adaptable to many applications in analogue computers, angle data transmission systems, automatic control systems, and similar equipment. The resolver may be used also to perform such operations as synthesis of two voltages and rotation of co-ordinates. The resolver is a miniature rotatable transformer in which the angle between the primary (stator) and secondary (rotor) is continuously adjustable by mechanically turning the rotor. The stator and rotor each have two windings which are 90 electrical degrees apart. These windings are in high-permeability laminated cores, machined to extremely precise tolerances. The rotor is mounted in precision miniature ball bearings. The aluminum shell is recessed for simple flange mounting. Resolver is rated at 1–24 volts, 400 cycles input.

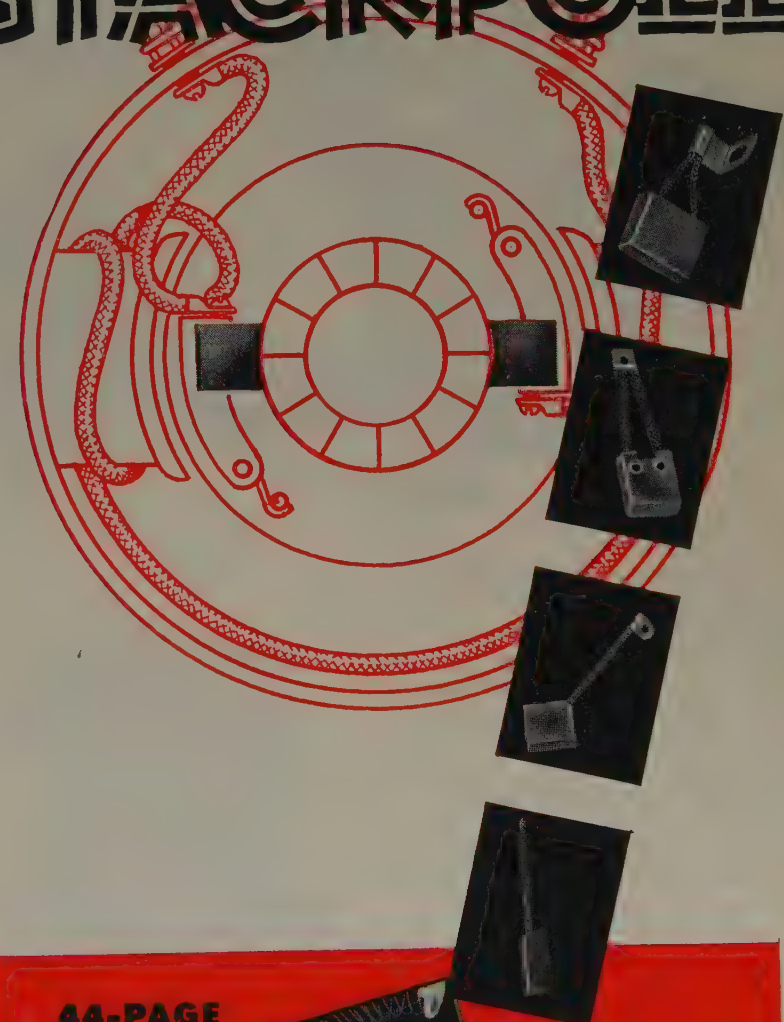
**TV Picture Tube.** The General Electric tube department has announced two new 21-inch television picture tube types whose 90-degree deflection angles make them about 3 inches shorter than corresponding narrower-deflection types. The tubes, types *21ACP4* and *21ACP4-A* (aluminized), are the fourth and fifth General Electric tube types to incorporate the 90-degree

(*Continued on page 54A*)











STACKPOLE

(*Continued from page 34A*)

deflection feature. Further information on the tubes may be obtained from the General Electric Tube Department, Schenectady 5, N. Y.

**Vibrating Conveyors and Screens.** The Syntron Company, 440 Lexington Avenue, Homer City, Pa., has announced an entirely new, complete line of balanced, dual-trough, vibrating conveyors and screens, for the conveying or screening, or conveying and screening and distributing, of bulk materials, hot or cold, dry or damp, abrasive or corrosive, from fine powders to big chunks. Descriptive literature complete with specifications is available from the manufacturer.

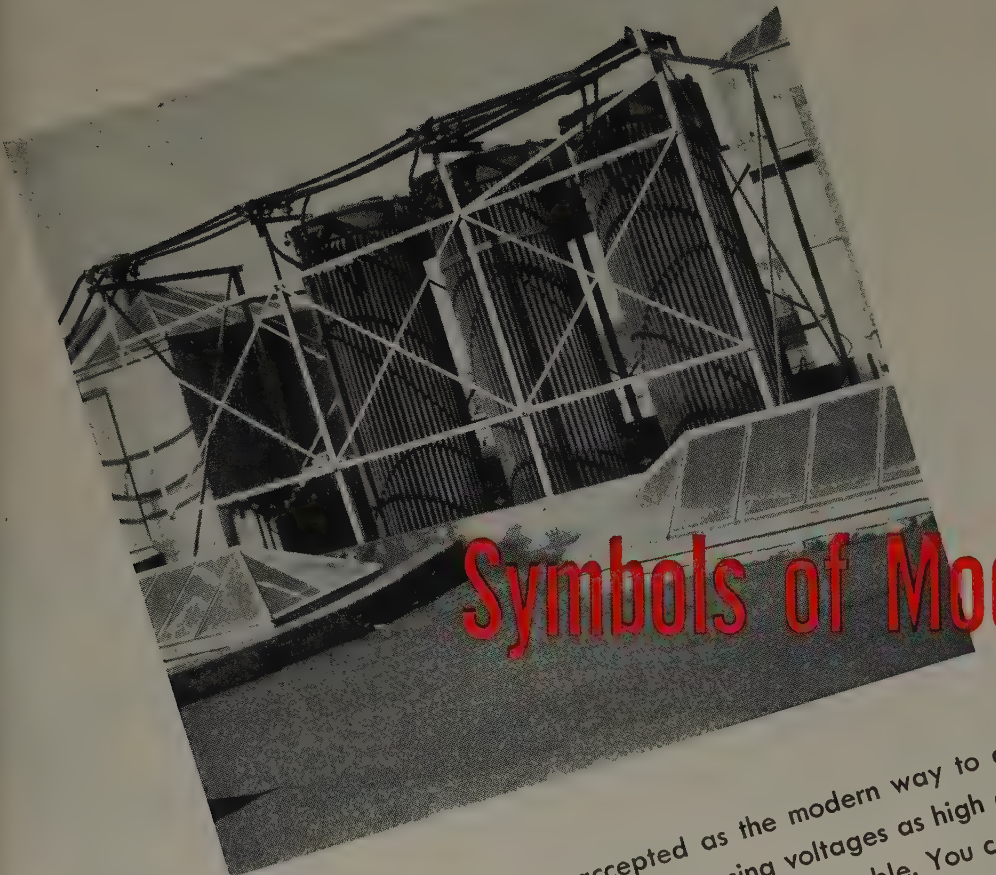
**Color TV Rectifiers.** International Rectifier Corporation, El Segundo, Calif., has announced a series of selenium rectifier stacks for color television sets. The rectifiers in this series are designed for capacitive loads of 600, 700, and 750 milliamperes and are produced for maximum input voltage ratings of 130, 172, and 195 volts rms. The construction of this series differs from regular radio and television selenium rectifiers. A bellows-type spring contactor as used in quality industrial rectifiers is employed in the assembly of this series. This spring contactor affords a lower forward drop, lower temperature rise, and longer life. Bulletin *ER-178* Supplement covers the electrical and mechanical specifications.

**Molded Nylon Caps.** Caps of Du Pont nylon for reference electrodes are being molded and used by the Leeds and Northrup Company, Philadelphia, Pa., to improve performance of their industrial and laboratory *p*H measuring devices. Nylon's resistance to high temperatures and chemical attack considerably lengthened the service life of flow-type and immersion-type electrodes. During tests, nylon-capped electrodes were boiled steadily for 9 months in solutions with *p*H's varying from 3 to 14 with no effect on the material other than a slight discoloration.

**Klystron Tube Tester.** Polarad Electronics Corporation has announced the availability of the first commercial Klystron Tube Tester. With this instrument, it is now possible to provide simple and conclusive preoperational tests for Klystron tubes resulting in substantial savings of engineering time. The tube tester provides complete metering facilities, control adjustments, precautionary means for safe testing at high voltages, and convenient tube data charts for rapidly determining control settings. For further information write Polarad Electronics Corporation, 100 Metropolitan Avenue, Brooklyn 11, N. Y.

**Sweep Alignment Generator.** A new instrument has been developed to meet the

(*Continued on page 56A*)



# Symbols of Modernization

Unit load centers are rapidly becoming accepted as the modern way to distribute power inside an industrial plant. This frequently involves using voltages as high as 17,000 volts. That's too high a voltage to be trusted to just any ordinary cable. You can't afford mediocrity in these important cables. Simplex-ANHYDREX XX should be your choice.

Simplex-ANHYDREX XX is a product of Simplex research and development. It is an insulation that is absolutely "tops" in the high voltage field. It is designed to operate at a maximum of 176°F. (80°C.) copper temperature.

Simplex-ANHYDREX XX has all the properties you want in a high voltage rubber insulation. It withstands heat, ozone and aging, and it is guaranteed not to absorb more than 15 milligrams of water per square inch of exposed surface when tested in accordance with U. S. Coast Guard standards.

So far as we know it is the only insulation of its kind. Use it wherever you have a high voltage problem, whether the cables are to be installed directly in the earth, underground in ducts, underwater, or overhead supported from messenger wire.

Simplex-ANHYDREX XX Cables are available in single and multiconductor styles for voltages from 2,000 to 17,000 V.W.P.

*Simplex*

**SIMPLEX WIRE & CABLE COMPANY, 79 Sidney St., Cambridge 39, Mass.**

*(Continued from page 54A)*

critical requirements for ultrahigh-frequency alignment. The development of this equipment is an all-electronic sweep that features no moving parts. Identified as Model *697*, this instrument provides fundamental output on all channels from 14 to 83. The elimination of the use of confusing and erratic harmonics is a big reason why this equipment considerably will speed up and improve the accuracy of ultrahigh-frequency alignment tasks. Complete technical details are available. Write for Form *697* to the Hickok Electrical Instrument Company, 10515 Dupont Avenue, Cleveland 8, Ohio.

**Direct-Reading Signal Generator.** A compact new signal generator offering direct frequency setting and readings from 7,000 to 11,000 megacycles now is being manufactured by the Hewlett-Packard Company. Known as model *620A*, the new generator is designed to simplify all superhigh-frequency measurements including sensitivity, selectivity and rejection, signal-to-noise ratio, conversion gain, standing wave ratio, antenna gain, and transmission-line characteristics. It also may be used for slotted lines, waveguide, and filter networks. Model *620A* includes internal or external pulse modulation, internal square-wave modulation, frequency modulation, and continuous wave output. For further information write Hewlett-Packard Company, 395 Page Mill Road, Palo Alto, Calif.

**D-C Insulation Tester.** A high-voltage d-c insulation tester for use in maintaining electric apparatus has been developed by the Line Material Company. The unit is portable. Utilizing the d-c leakage principle for nondestructive testing, the tester operates on a 115-volt 60-cycle supply to provide adjustable direct test voltages from 1 to 15 kv. It measures d-c insulation resistances up to 30,000 megohms. The tester has a microammeter for measuring d-c leakage through the insulation being tested and a meter for indicating the voltage across the insulation. For further information write Line Material Company, Milwaukee 1, Wis.

**Precision Film-Type Resistors** A superior molded boron carbon unit, type *MBC*, rated at 1/2 watt has been developed by International Resistance Company. This resistor is molded in a special plastic housing to provide complete mechanical protection and features greatly improved moisture, load life, and shelf life characteristics over unmolded. This new unit is particularly recommended for application where stability, accuracy, high-voltage insulation, and economy are prime requisites. For further information, write International Resistance Company, 401 North Broad Street, Philadelphia 8, Pa.

**Sonic Liquid Level Indicator.** A liquid level indicator system, model *SL-101*, using ultrasonic pulse ranging technique has

*(Continued on page 60A)*

## ard HEAVY DUTY TRIP-OUT 16234-3

### TEST DATA

Voltage 14,400 KV; Power Factor 20%; X/R=4.88

| Cutout Cat. No. | Test No. | Current Amperes RMS | Clearing Time Cycles | Kearney Fuse Link | |
|---|---|---|---|---|---|
| | | | | Rating | Type |
| 16234–3 | 1 | 8050 | ½+ | 80 | 200-U |
| 100 Amp. | 2 | 7620 | ½+ | 80 | 200-U |
| 15 KV | 3 | 8750 | ½+ | 80 | 200-U |
| | 4 | 8320 | ½+ | 80 | 200-U |
| | 5 | 8750 | ½+ | 100 | 200-U |
| | 6 | 7900 | 2½ | 100 | KS-U |

**RATING:** 100 amperes, 15 KV.

**RESULTS:** At 14.4 KV with a power factor of 20%, the cutout sucessfully interrupted six shots ranging from 7620 to 8750 amperes, RMS. After the sixth shot both the cartridge and contacts were carefully examined and found to be in perfect working condition.

After the short circuit test, without adjustment of any kind, the cutout was tested for temperature rise. The maximum was 13° C, as compared to 30° allowable by NEMA for new cutouts.

# ACTUAL TEST DATA on Short Circuit Interruptio

# PROVES KEARNEY HEAVY DUTY Cutouts Have Ample Interrupting Capacity for Today's Heavy Loads

## dard HEAVY DUTY TRIP-O-MATIC indicating 12143-20 non-indicating 12143-21

### TEST DATA

Voltage: 5046; Power Factor: 20%; X/R=4.88

| Cutout Cat. No. | Test No. | Current Amperes RMS | Clearing Time Cycles | Kearney Fuse Link | |
|---|---|---|---|---|---|
| | | | | Rating | Type |
| 12143-20 | 1 | 7250 | 1 | 50 | KS |
| 100 Ampere | 2 | 7680 | 1 | 80 | 200 |
| 5 KV | 3 | 6620 | 1 | 80 | 200 |
| Indicating | 4 | 6200 | 1½ | 80 | 200 |
| | 5 | 7850 | 1 | 100 | 200 |
| | 6 | 6400 | 1½ | 100 | 200 |
| | 7 | 6600 | 1 | 100 | 200 |
| | 8 | 6200 | 1½ | 100 | 200 |
| | 9 | 7250 | 1 | 100 | 200 |
| 12143-20 | 1 | 6600 | 1 | 100 | 200 |
| (original box) | 2 | 6880 | 1 | 100 | 200 |
| (with new door) | 3 | 7050 | 1½ | 100 | 200 |
| 12143-21 | 1 | 2900 | 1½ | 50 | 200 |
| 100 Ampere | 2 | 4250 | 2½ | 100 | 200 |
| 5 KV | 3 | 7850 | 1 | 50 | KS |
| Non-Indicating | 4 | 6750 | 1 | 50 | KS |

**RATING:** 100 ampere, 5 KV.

**RESULTS:** At 5 KV with a power factor of 20%, the indicating Trip-O-Matic successfully interrupted nine shots ranging from 5500 to 6350 amperes, RMS, at 5046 volts. Then three additional tests were made on the same box with a new door installed. 5800, 5750 and 6050 amperes were successfully interrupted. The non-indicating Trip-O-Matic successfully interrupted four shots ranging from 2800 to 6000.

After the short circuit tests, a heat run was made on the same non-indicating box. Maximum temperature rise was found to be 21° C, as compared to 30° allowable by NEMA for new cutouts.

**TEST SET-UP:** This circuit interruption data is *not based on calculation*. It is the result of actual field tests at Kearney's 34.5 KV substation. Power was taken from the Union Electric circuit providing a 445,000 KVA back-up. In the Heavy Duty Trip-Out tests, faults were made on the 15 KV side of a 10,000 KVA transformer. In the Heavy Duty Trip-O-Matic tests, faults were made on the 5 KV side of the same transformer.

These test results are proof-positive that Kearney cutouts protect your circuits with *even greater* capacity than their normal ratings.



JAMES R. KEARNEY CORPORATION ST. LOUIS, MO. GUELPH, ONT.

(*Continued from page 56A*)

been developed by Bogue Electric Manufacturing Company, 52 Iowa Avenue, Paterson, N. J. This new system, which uses no moving parts such as floats, synchros, potentiometers, and switches, has been designed to indicate accurately true liquid levels in petroleum, chemical, and pharmaceutical processing and storage tanks within ±0.01 foot. Level readings are always correct due to the action of an automatic calibration system that compensates for any changes in the velocity of sound propagation which may be caused by varying temperatures, specific gravities, and similar differences between liquids being gauged.

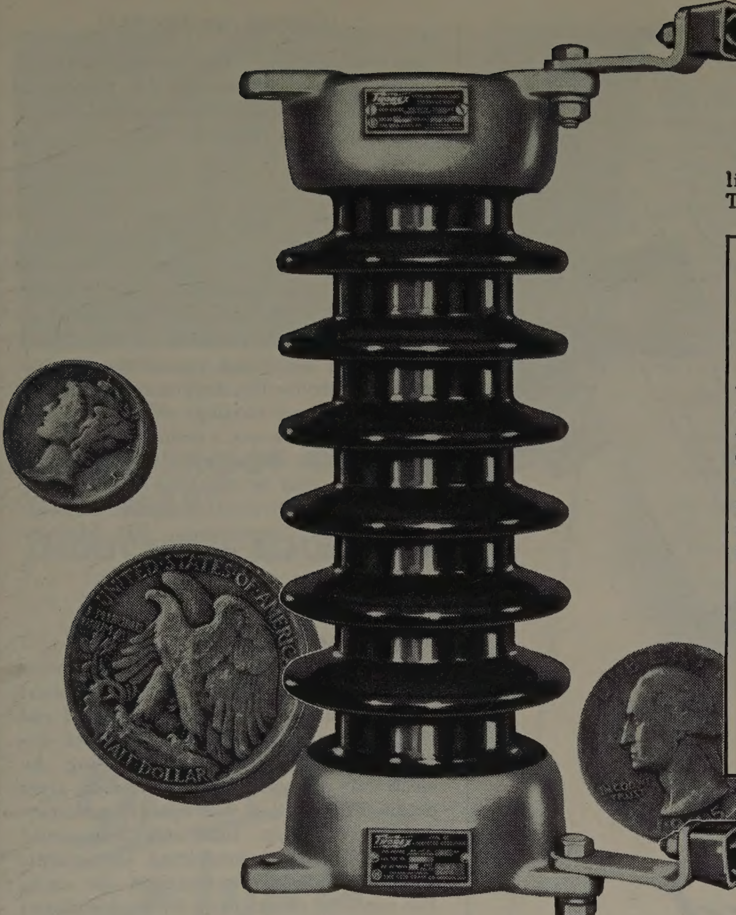
## TRADE LITERATURE

**Long-Scaled Switchboard Instruments.** A 24-page bulletin on long-scaled switchboard instruments has been announced as available from the General Electric Company, Schenectady 5, N. Y. Designated *GEC-218C,* the publication contains a description of the company's *AB-DB-18* instrument lines as well as principles of operation, characteristics, and specifications. Prices and dimensions also are provided.

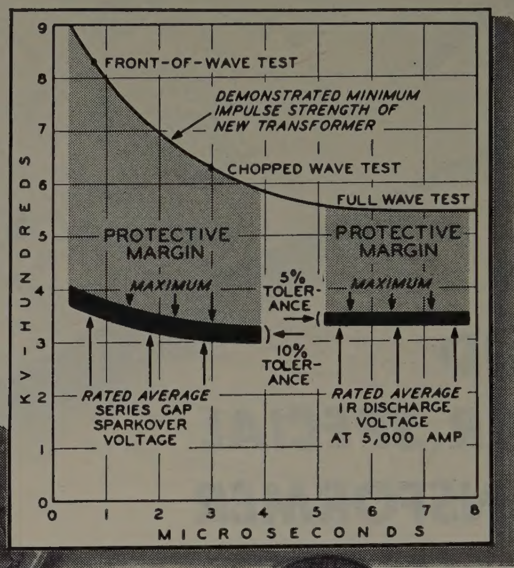
**Motocylinder Booklet.** A new booklet describing the integral-type Motocylinder for material-handling applications is available from the Westinghouse Electric Corporation. The Westinghouse Motocylinder is an adaption of a gearmotor, utilizing a high-torque high-slip electric motor and a short, rugged crank on the output shaft to transform rotary to reciprocating motion. Included in the integral-type Motocylinder units are cams, limit switches, and motor brake that can be set and co-ordinated to stop the crankpin at around-the-clock positions. The booklet describes how Motocylinders can be employed to flip, turn, release, raise, or lower material in repetitive cycles. Ratings and characteristics of the complete line of standardized Motocylinders are given. For a copy of the booklet, *B-6190,* write Westinghouse Electric Corporation, Box 2099, Pittsburgh 30, Pa.

**RCA Issues New Catalogue.** A 28-page catalogue describing new low-loss coaxial transmission lines and fittings for ultra-high-frequency television broadcasting stations has been issued by the RCA engineering products department. The illustrated booklet provides important information on $3^1/_8$- and $6^1/_8$-inch transmission lines, fittings, and accessories with complete tables of efficiencies for channels 2 to 83, inclusive, for distances ranging from 100 to 1,600 feet. In addition to complete technical specifications, the brochure provides important information on layouts

(*Continued on page 64A*)



Typical protective performance of a Thorex lightning arrester, illustrating Rated Averages, Tolerance, Maximums, and "Protective Margin."




# how to figure the value of a lightning arrester

Is there any positive way to measure your money's worth in the purchase of a lightning arrester? Actually, you can arrive at such a figure, accurate to the second decimal place!

Take rated average catalog IR discharge values. To these add the manufacturer's tolerance. The sum of the two is MAXIMUM protective level -- the only realistic point from which arrester performance can be measured. *Every* Thorex arrester meets or improves on this value. You already know the minimum impulse insulation strength of your equipment. Between the two is a zone called "Protective Margin". It is expressed in kv. Cost of your arrester is expressed in dollars. See what you *pay per kv* of Protective Margin and you will end up buying the O-B Thorex -- giving you not only the greatest protection per dollar, but the greatest protection regardless of cost!

**Ohio Brass**

**MANSFIELD OHIO, U.S.A.**

4422-H

(*Continued from page 60A*)

and installation. The catalogue, Form *B.767*, may be obtained by writing to Broadcast Equipment Sales, RCA Victor Division, Radio Corporation of America, Camden 2, N. J.

**Resin Coatings.** A new 8-page folder, "Bakelite Resin Coatings for General Industry," has been issued by Bakelite Company, a Division of Union Carbide and Carbon Corporation. The folder reports on decreased maintenance costs, extended service life, and other advantages these protective coatings afford the construction, petroleum, chemical, food, and transportation industries. Copies of this folder, *VG*, may be obtained from Bakelite Company, a Division of Union Carbide and Carbon Corporation, 300 Madison Avenue, New York 17, N. Y.

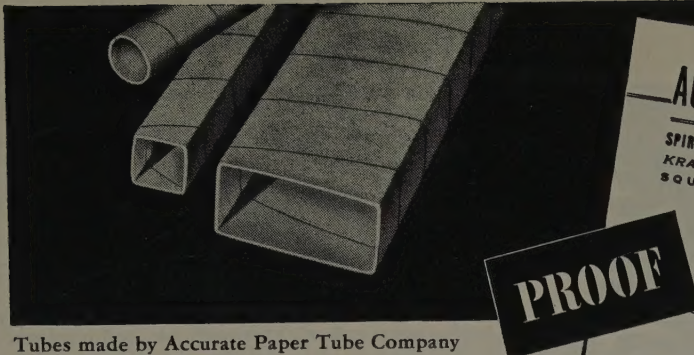
**Measurement Bulletin.** Bulletin *1-1* presents the latest technical data on measuring resistance of man-made grounds; theory, application, and methods of soil resistivity measurement; and a brief discussion of geophysical prospecting by electrical methods. The bulletin gives detailed description and operating characteristics of eight basic "Vibroground" ground resistance measuring instruments and "how-to-use" instructions for each. For copies of this bulletin write, Associated Research Incorporated, 3754 West Belmont, Chicago 18, Ill.

**Fluorescent Lamp Ballast Bulletins.** Two new bulletins covering the installation, use, application, and selection of fluorescent lamp ballasts have been announced as available from the General Electric Company, Schenectady 5, N. Y. An 8-page bulletin, *GEC-983A*, provides specification charts for selection of ballasts and includes wiring diagrams and cross-section dimensions. A 12-page publication, *GET-922F*, describes fluorescent lamps and starters and gives operating characteristics of all types of fluorescent lamp ballasts as well as installation suggestions.

**Liquid-Level and Air-Flow Detector.** Application ideas, installation tips, and suggested circuits for utilizing the recently announced Detect-A-Flo unit, a versatile device that controls or detects both liquid level and air flow, are presented in a new 16-page illustrated booklet. In addition to a variety of application information, the booklet also discusses the principle of operation of this unusual device, which has no moving parts, is hermetically sealed, and is installed directly in the tank or air stream being monitored. Copies of the booklet may be obtained upon request by writing to Fenwal Incorporated, Ashland, Mass.

**Resistors.** Comprehensive data on the International Resistance Company's

(*Continued on page 68A*)




Tubes made by Accurate Paper Tube Company using Quinterra Type 3.

**ACCURATE PAPER TUBE CO.**

SPIRAL WOUND TUBES FOR THE ELECTRICAL INDUSTRY
KRAFT-FIBRE-CELLULOSE ACETATE-ASBESTOS
SQUARE :: ROUND :: RECTANGULAR

TELEPHONE CHESAPEAKE 3-9646

850 N. NOBLE STREET
CHICAGO 22, ILLINOIS

September 21, 1951

Mr. H. F. Pokorney
Johns-Manville Sales Corp.
Merchandise Mart Plaza
Chicago 54, Ill.

Dear Mr. Pokorney:

We thought you would like to know about the excellent performance being reported for our spiral-wound tubes made of silicone-treated Quinterra Type 3.

Manufacturers of transformers and magnet coils wound on Quinterra Type 3 tubes find that the equipment can operate continuously at temperatures up to 200 degrees C with no damage to the tubes.

Bell ringing and control transformers wound on Type 3 tubes can be designed to burn out under short circuit and still withstand 1500 volt potential from coil to ground.

Tubes are made in a full range of sizes for coil and transformer applications.

Very truly yours,

ACCURATE PAPER TUBE CO.

Leon Levinthal

Leon Levinthal

# HERE'S PROOF THAT YOU CAN MAKE INDUCTION EQUIPMENT

# *Safer... Smaller... at Lower Cost...*

# with silicone-treated *Quinterra** TYPE 3

(A purified Asbestos Class H sheet insulation)


TRANSFORMER WITH CONVENTIONAL INSULATION

TRANSFORMER WITH SILICONE-TREATED QUINTERRA TYPE 3 INSULATION

Photograph above shows two signal corps transformers having same rated output—illustrating savings in space and materials made possible by use of silicone-treated Quinterra.

(Photo — Courtesy Chicago Transformer Division, Essex Wire Corporation.)

**A**s the above letter from the Accurate Paper Tube Company testifies, users of this newest Johns-Manville electrical insulation find that it raises overload limits and assures greater safety.

And as you can see from the photograph at left, Quinterra Type 3 also permits important savings in both space and materials . . . a fact substantiated by leading manufacturers of quality transformers.

You can not only improve your induction devices with Quinterra Type 3 . . . but you can also reduce the total cost of production because rejections will be minimized.

Silicone-treated Quinterra Type 3 is a high grade Class H dielectric . . . ideal for both interlayer and wire-wrapping insulation as well as the formation of tubes. It has outstanding moisture resistance, high temperature stability, and electrical characteristics—plus flexibility and adequate physical strength for many applications.

Quinterra Type 3, like all treated Quinterras, is made from a completely inorganic base sheet of purified asbestos that has a hole-free closed structure. This sheet has an inherent dielectric strength of at least 200 VPM which is retained even under temperature of 400 C. The silicone-treated sheet maintains a dielectric strength of at least 225 VPM under continuous exposure to temperatures in excess of the Class H maximum, 180 C.

If you have a problem that Quinterra Type 3 may solve, why not consult our sales engineers—without obligation? For samples and additional information, write Johns-Manville, Box 60, N.Y. 16, N.Y.

*Quinterra is the registered trade mark of Johns-Manville's purified asbestos electrical insulation.

JOHNS-MANVILLE JM PRODUCTS

# Johns-Manville ELECTRICAL INSULATIONS

(*Continued from page 64A*)

molded boron-carbon resistors, Type *MBC* have been made available. Data on characteristics, applications, tolerance, winding terminations, dimensions, insulation, charts, and graphs are included in their Bulletin *B-8*. Write International Resistance Company, 401 North Broad Street, Philadelphia 8, Pa., for copies.

**Thermocouple Protection Tube.** Publication of a new bulletin describing a metal-ceramic thermocouple well has been announced by the Bristol Company. The bulletin outlines all properties and specifications of the new protection tube, which combines the thermal conductivity and shock resistance of metal with the corrosion and deformation resistance of ceramics. The wall of the tube has the same thermal conductivity as cast iron, and although it is only 1/8 inch thick, only single-wall construction is needed. The Metal-Ceramic *LT-1* well is resistant to both air oxidation and combustion gases at high temperatures, as well as to attack by molten steel and slag. The 4-page illustrated bulletin, Number *P1261*, gives complete physical properties, dimensions, and catalogue order numbers. Copies are available on request by writing, Release Number 758, The Bristol Company, Bristol News Service, Waterbury 20, Conn.

**New Lighting Manual.** A detailed 16-page brochure describing Cutler MIRAC-O-LITE, the entire line of Cold Cathode Fluorescent lighting equipment produced by the Cutler Light Manufacturing Company, has been published recently. This manual is now available, upon request, to all who are interested in commercial, industrial, and institutional lighting. Address, Cutler Light Manufacturing Company, 2024–28 North 22d Street, Philadelphia 21, Pa.

**Reference Book on Instruments.** A new 64-page reference book titled "Research and Control Instruments—X-Ray and Analytical Equipment" is available from the Research and Control Instruments Division, North American Philips Company, Inc., 750 South Fulton Avenue, Mount Vernon, N. Y. In addition to X-ray diffraction, spectrometry, and spectrography, the volume covers such components and accessories as tubes, rectifiers, and cameras.

**New Electrode.** A new electrode, tradenamed XYRON, with a specially designed coating, has been developed for welding cast iron by the Eutectic Welding Alloys Corporation. There is an unusual density of deposits, and cracking, cross-checks, and so forth, have been practically eliminated. The amperage requirements are extremely low; the 3/32-inch electrode operating on 35 to 75 amperes. An illustrated booklet may be obtained free of charge from the Eutectic Welding Alloys Corporation, 40–40 172d Street, Flushing 58, N. Y.